European Commission

# Joint Research Centre

## The European Commission's science and knowledge service

# Annual Report 2017

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Joint Research Centre

**European Commission**
**Joint Research Centre**

**Annual report 2017**

Report on the activities, accomplishments and resources related to the JRC's work carried out in 2017. An overview is given of the scientific achievements and activities as well as of corporate initiatives.

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# Foreword by Commissioner Tibor Navracsics

2017 was a special year for the JRC. Not only because we celebrated its 60th anniversary but also because it started to reap the benefits from its new strategy and organisation.

In 2017, the JRC provided support on several important and complex policy matters. For example, it quickly responded to the fipronil scandal and helped addressing the dual food quality issue, demonstrating that its independent advice is appreciated not only by other Commission services, but also by stakeholders and Member States.

The JRC also played an instrumental role in several key initiatives of the European Commission such as the European Pillar of Social Rights, the legislative proposals for the Energy Union, the CAP modernisation and simplification process and the European Semester.

I am proud that the JRC's excellent work is appreciated and deployed outside the EU. Its Smart Specialisation concept has been taken up in Canada, Australia and South-America, while its knowledge, tools, models and research are serving policymakers across Africa, as demonstrated in its report published in 2017 which brings together 30 years of knowledge on Africa.

I am also proud that the JRC is now a recognised global player in Science Advice to Policy and has an important role in Knowledge Management inside the Commission, for example with its Knowledge and Competence Centres or its work on data management and visualisation.

The JRC is also focusing on emerging challenges. It developed the first comprehensive framework for resilience in the Commission and the first comprehensive report on Fairness within the EU, and it also analyses various aspects of the digital transformation, including cyber security and Artificial Intelligence.

Last but not least, the JRC is experimenting with innovative approaches such as exploring the intersection of art and science that culminated in the success of the Resonances II festival in the Leonardo Da Vinci museum in Milan.

These are only few examples of the Joint Research Centre's achievements in 2017, and I am optimistic that the future holds even greater promise. Its track record over 60 years, its dedicated staff, unique competencies, global network and its partners inside EU institutions and Member States are its greatest assets. Our challenge and our opportunity for the next years is to safeguard these assets together and ensure that they continue to serve European citizens for the foreseeable future.

**Tibor Navracsics**
European Commissioner for Education, Culture, Youth and Sport


# Observations from the Board of Governors

After a year of many changes within the JRC as well as in EU policies as a whole, 2017 can be described as a year of implementation. The JRC strategy 2030 introduces numerous changes that consolidate the JRC's new orientations and open it up to new fields of activity. The Board of Governors (the Board) is very satisfied with the level of activity and the thoroughness of the JRC's implementation of the strategy and will continue to follow and monitor it regularly in the coming years.

The Board is also pleased to see increased interaction within the European Commission and beyond, and the strengthening of the JRC's responsiveness to the adopted changes in political priorities, while maintaining a high level of scientific excellence. The JRC's input to policymaking in other DGs has been fully acknowledged, and is now established as part of the daily internal routines of the European Commission.

In particular, the Board appreciates the JRC's efforts in effective knowledge management and the launch of several knowledge and competence centres. These highlight the JRC's commitment to supporting priority policy areas through scientific knowledge.
As one of the main developments of the year, the JRC opened access to its research infrastructures to Member States, Horizon 2020 (H2020)-associated countries and other external stakeholders. This will not only make best use of many of the JRC's research labs, it will also allow the JRC to engage more intensively with key stakeholders.

The Board has already given a favourable opinion on the work plan for 2018-2019. The Board welcomes in particular the fact that the work programme addresses the JRC's different priority nexuses in a balanced manner, showing significant progress in opening the JRC's work to newly prioritised areas of the European Commission.

Finally, the Board congratulates the JRC on the celebration of its 60th anniversary and its accompanying activities. The JRC institutional history project and the jubilee events highlighted the long way the JRC has travelled from its foundation as a nuclear research centre to its current role as a unique institution for science-to-policy support. The Board hopes the JRC will continue to evolve successfully to address the changing challenges of the future.

The Board endorses the present annual report and expresses its appreciation for the good work of the JRC's staff, and will continue to actively support it in 2018.

# IMPLEMENTING THE JRC STRATEGY 2030 AN INTERVIEW WITH THE JRC DIRECTOR GENERAL, VLADIMÍR ŠUCHA

2017 represented the first full year of implementation of JRC. It is therefore an excellent moment to take stock of progress. We invited the JRC Director General, Vladimír Šucha, to share his views and insights during a video interview. The questions and answers reported below represent an edited transcription of the full interview, an extract of which can be accessed in video format at: *https://ec.europa.eu/jrc/publications/AR2017*

## What led to the adoption of the strategy?

The JRC stands at the crossroads between science and policy and as such it must reflect the needs of policy, whilst retaining its scientific credentials and being at the forefront of research. On both sides, fundamental changes have been and are taking place. EU Policies are becoming much more complex, more dynamic and influenced by global issues.

But also in science, we are witnessing a huge change. On the positive side, we have more data, we have more information, we are more technology-driven, and technology is pushing us forward at an unprecedented speed. On the not so positive side, there are issues of scientific integrity, science is not sufficiently multidisciplinary, and science is not always able, at least alone, to answering the most pressing societal questions.

All in all these changes create quite a dynamic environment in which the JRC needed to reinvent itself to address these new challenges and opportunities.

## What's your take on 2017, the first full year after the new JRC strategy and reorganisation?

Obviously 2017 was a very special year for the European Union, for the European Commission, and for the JRC as we celebrated the 60 years of the treaties. As directly established by the Euratom treaty, the JRC looked back indeed at 60 years of successful evolution and adaptation.

2017 was also the 1st year of full implementation of our strategy 2030. My experience with the JRC stretches back 17 years, and in my view this was the best and most successful year I can recall.

If two external evaluations are praising the JRC for its best performance and successful implementation of changes in 20 or 25 years, if many people are describing us using terms such as 'impressive change', 'high-speed change', 'the right way', or 'role-model for other organisations', maybe what we did, what we are trying to do is on the right track. Obviously we are not there yet, because it was the first full year, but I think it was an extremely successful year.

2017 was also an outstanding year for communications. Our exponential trajectory in social media is impressive - our media coverage doubled in comparison with the previous years with nearly 4200 mentions of JRC in the media. I think these are indicators that what we do is of interest to others.

## What were the noteworthy new initiatives in service of the strategy?

I would pick two examples. The first one is our collaborative doctoral partnerships. We launched the call for expressions of interest and were pleased to see how many top class universities responded. We are now starting to work on

providing students with the training and opportunity to better understand the science-policy interface.

As a second example, 2017 was also the 1st year of launching our Centre of Advanced Studies; this is where we would like to bring in innovative ideas and fresh talent from outside the organisation in emerging fields where our in-house expertise isn't yet up to speed.

So, we are looking to work with external experts for a limited period of time helping us digest new areas of knowledge.

## Why is knowledge management an important pillar of the strategy?

The data, information and knowledge deluge is one of these huge challenges that affect research and non-research organisations alike, not least public organisations like the European Commission.

If we do not manage knowledge, if we do not manage the data and information which is underlying our knowledge, then we are lost. We are lost in this tsunami. It is like a huge wave: either you use the strength and power of this wave and you take the opportunities it offers, or you are swept away.

It's not enough to know what we do and to provide our services to the Commission, to the Member States, or to the rest of the world. No, absolutely not. We need to know that what we are providing is state of the art, taking into account all knowledge that is available elsewhere, which is filtered, verified, and absolutely relevant and credible.

So we embark on a journey of the unknown. It triggers a lot of questions from people, but this is very normal: we don't know how to do it. Nobody does!

It's like a jigsaw, we have bits and pieces here and there, we are learning from these, but actually how to manage the volume of knowledge in so many fields and how to build that coherent bigger picture, is where we need to be inventive and innovative.

## How do we go about sharing knowledge?

First and foremost, we need to share knowledge and communicate in-house. One of the most important elements of the strategy is breaking internal silos. Every policy question is very complex and there is no one department, one unit of the JRC which can provide answers alone.

*'The data, information and knowledge deluge is one of these huge challenges that affect research and non-research organisations alike, not least public organisations like the European Commission.,*

And then obviously, we need to communicate beyond our own house, we need to somehow transmit the knowledge to our partners. What we need to do is to 'translate' policy requests into research questions, and research results into policy relevant, actionable knowledge.

For the outside world it is obviously a completely different story. We need to simplify information yet preserve content and avoid distortions.

In both respects, the past 2-3 years have seen us improve quite significantly, not least in the way we interact with policy-makers.

## How do we foster cultural change inside JRC?

Cultural change always is the most difficult and it takes a long time. Our brain is in a way designed so we think in silos, so we think within a certain frame. Breaking this is a fundamental challenge.

I must say though, that I'm impressed by people in the JRC. I'm aware that implementing the strategy represents a fundamental change; I am convinced that this change is needed and I am very impressed by how all colleagues across the JRC align with it. Most of them embrace it and start reaping the benefits for themselves, for their communities and for the organisation as a whole.

My message is that throughout my life I've been working across disciplines, and I must say this is a wonderful experience, it is a fulfilling experience discovering new horizons by talking to different people from different disciplines and moving society forward by innovating.

I think it is encouraging for all of our staff to see that our organisation is recognised both for its scientific excellence and policy relevance. We are praised by our colleagues; we are in demand by our colleagues across the Commission and at the same time we have maintained and even improved our scientific excellence over the past year. I think this is very good.

‘We need to “translate” policy requests into research questions, and research results into policy relevant, actionable knowledge.’

# CELEBRATING 60 YEARS OF SCIENTIFIC EXCELLENCE

On 25 March 1957, six countries (Belgium, Germany, France, Italy, Luxembourg and the Netherlands) signed in Rome the Treaty on the European Economic Community and the Treaty on the European Atomic Energy Community (Euratom). The latter established a Joint Nuclear Research Centre (JNRC) and gave it its first 5-year work plan. 2017 marked the 60th anniversary of these fundamental events. It was naturally the occasion to look back at decades of JRC history and its evolution over time. It was also a good cause for celebrations.

22 July 1959, Rome – official signature and handover ceremony of the Ispra Centre (Joint Nuclear Research Centre) to the European Economic Community

# 60 years of JRC history

In the years following its establishment, the JNRC was a multi-site organisation, bringing national nuclear research centres under the Euratom umbrella. Scientific work started swiftly but laboratories and research reactors needed some time before they became operational in Ispra (Italy), Petten (the Netherlands), Geel (Belgium) and Karlsruhe (Germany). In scientific terms, the JNRC started as a nuclear research organisation, working on non-military nuclear technology.

In the 1970s the 'N' was dropped from its name when it officially started to work in non-nuclear fields: environment, remote sensing, and renewable energies (photovoltaics) were among the many scientific topics already addressed in that period — and they are still part of today's work. The first energy crisis and a growing awareness of the limits of growth required new policy responses, for which EU leaders needed reliable and trustworthy science. Many alternative energy scenarios began appearing, including hydrogen.

Remote sensing — often from satellites — is another important field. As early as the 1960s the then JNRC printed maps of the agricultural areas of the then Soviet Union from the United States' space agency NASA's satellite data records. By the late 1980s, the Commission's agricultural policy was looking for a cost-effective way to survey agricultural land in the EU; the JRC was ready to apply its expertise.

Initially, nuclear technological research and development was the JRC's focus. Then it shifted to work on understanding, mastering and developing technologies for a range of applications, such as measuring chemicals in the environment in situ and remotely. In the 1980s and 1990s it increasingly oriented its work towards policy support. As the JRC evolved, so too did its approach to what it studied.

In 1998 the Baveno manifesto called for developing a European space programme starting from the intended uses, rather than from the available technologies. That has become the JRC's

approach in many domains: new work starts because an answer is needed to a policy question, not because we have a new technology at hand. The JRC strategy 2030, unveiled in 2016, reflects this. In it, the JRC is 'to play a central role in creating, managing and making sense of collective scientific knowledge for better EU policies'.

Today, the JRC has 2 787 staff at six sites in five countries: Belgium, Germany, Italy, the Netherlands, and, since 1996, Spain. With headquarters in Brussels, it is the only Commission service that carries out research and scientific activities in-house. It supports the entire European Commission in its function from initiating EU policies to implementing them. This covers the entire policy cycle, from identifying a need for action, testing policy options, providing scientific evidence for the design of policy and its implementation, and finally monitoring and evaluating the implementation.

Drawing on its wealth of expertise and more than 50 world-class research facilities, the JRC adds value to the EU because its science is excellent, multidisciplinary and independent of Member States, industry or other interests. Serving the whole Commission as its science and knowledge service, it provides holistic, multidisciplinary and interdisciplinary policy support. The JRC also shares its know-how with the Member States, the scientific community, international partners and EU citizens.

## *60 stories for the 60th anniversary*

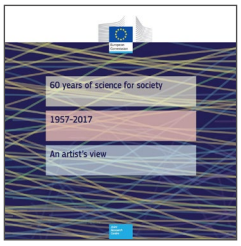

This publication celebrates the JRC's 60 years with 60 short stories suggested by JRC staff and edited for the interested citizen. The publication was acknowledged by the Commission's clear writing awards. Taken together, the stories highlight the breadth and depth of the JRC's work through the decades, delivering excellent science to serve society.

## *The institutional history project*

iHiP

The JRC has started its institutional history project (iHiP), which aims to establish an official history of the JRC, exploiting the estimated 13 km of documents accumulated since its early days. In an innovative approach, these documents will be digitised and subsequently archived with the help of automatic text mining and analysis, based on artificial intelligence and machine learning. This growing corpus of digitised documents will be explored with innovative analytical techniques to identify and visualise interconnections and trends. These techniques are increasingly needed to deal with the tsunami of scientific data and publications, and iHiP will further develop the expertise of the JRC in this field.

## 60 years of science for society 1957-2017: an artist's view




As one of the first outputs of the iHiP described above, this publication tells the story of the JRC in a new science-based artistic visualisation of the information and data contained in documents covering its 60-year history.

## Exhibition at the European Commission's headquarters

An exhibition celebrating the JRC's 60th anniversary and showcasing six decades of science and knowledge informing policies was set up in the European Commission's Berlaymont building. After navigating a 'maze of knowledge' constructed with walls built from the myriad of reports and studies of the JRC, participants could find out more about the JRC's work with interactive videos, displays and even a virtual reality programme.

## Local JRC events

The 60th anniversary was also celebrated with local events across all JRC sites.

In Ispra, a ceremony was organised together with the Italian Civil Protection and the Italian Fire Brigade. Under the theme of civil protection, the celebration highlighted the importance of collaboration with national authorities. It showcased what the JRC and the EU do to help Italy on priority issues like disaster risk management to prepare for and respond to earthquakes, floods, forest fires and landslides. The event was co-organised with the European School Varese (ESV) and around 800 students from the ESV and local Italian schools participated in it.

In Karlsruhe, the celebrations focused on the Euratom Treaty, particularly on the role and benefits of Euratom supporting research and safety and safeguarding the peaceful use of nuclear energy in Europe. An awards ceremony rewarding pupils for their best artwork about the implications of the treaties in daily life was also part of the celebrations.

In Seville, the JRC participated in the European researchers' night, which aims at promoting science careers and highlighting the crucial role science has to play in society. On this occasion, colleagues made the 60th anniversary one of the main themes of their presentations.

# PROMOTING EVIDENCE-BASED POLICY: #EU4FACTS

‘Post-truth’, ‘post-reality’ and ‘post-fact’ are labels for an important phenomenon, which in 2017 perhaps more than ever before impacted the fragile relationship between science and policymaking. Why should we trust science? What is the role of science in times of fake news and ‘filter bubbles’? How can evidence and data be effectively balanced with values and emotions when policy decisions are taken? These are some of the important questions that were addressed on the occasion of the JRC 2017 Annual Conference and the JRC Annual Lecture 2017.


## JRC 2017 Annual Conference — EU4FACTS: evidence for policy in a post-fact world

Science and policy can be uncomfortable bedfellows. Science is about facts, but policymaking needs to find a balance between facts and values. This awkward interaction between science and policy is not new. But add into this mix the current post-fact debate and we can make out the contours of a crisis.

In this context, the JRC 2017 annual conference, 'EU for facts', gathered leading experts in science, policy and the media toshare ideas on charting a new course for organisations like the European Commission, which operate at the intersection of facts and politics. Economists, psychologists, philosophers, sociologists and natural scientists engaged with politicians, policymakers and journalists. Keynote speakers included Vice-President Jyrki Katainen, former Commissioner and Director-General of the World Trade Organisation Pascal Lamy, and Sir Peter Gluckman, Chair of the international network for science advice to governments. Commissioners Tibor Navracsics, in charge of the JRC, and Carlos Moedas also attended, as well as four other former Commissioners.

At the end of a full day of presentations and discussions, a set of actionable recommendations emerged on how the EU can make better policies informed by scientific evidence. Of these recommendations, the most directly relevant ones for the European Commission centred on promoting, teaching and publicly recognising the successful use of evidence by policymakers.

Another proposal was to offer behavioural training for Commission policymakers, making them more aware of the many ways that biases can creep into decision-making. Extract from the original article by Ciprian Begu, published in *Commission en Direct*

## JRC Annual Lecture 2017 — Ignorance and the community of knowledge

Coinciding with the annual conference's main theme, the JRC Annual Lecture 2017, 'Ignorance and the community of knowledge', explored how the illusion of understanding, common to all individuals, and the different weight values and logic have on influencing decision-making, are best addressed by knowledge communities driven by shared intention. Professor Steven Sloman of Brown University explained how our habits of thought influence the way we see the world and make decisions. Ian Vollbracht, a researcher at the JRC and leader on the research project 'big data, psycho-targeting and the future of democracy' reflected on whether communication methods could be used to develop Professor Sloman's ideas, and how organisations such as the European Commission might rethink the focus of their communication activities. The event was moderated by Simon Kuper, Financial Times journalist and co-author of Soccernomics, which tells the story of science in successful sports strategies.

Watch the JRC Annual Lecture 2017 recording here.

# MANAGING KNOWLEDGE FOR EVIDENCE-BASED POLICY

‘Post-truth’, ‘post-reality’ and ‘post-fact’ are labels for an important phenomenon, which in 2017 perhaps more than ever before impacted the fragile relationship between science and policymaking. Why should we trust science? What is the role of science in times of fake news and ‘filter bubbles’? How can evidence and data be effectively balanced with values and emotions when policy decisions are taken? These are some of the important questions that were addressed on the occasion of the JRC 2017 Annual Conference and the JRC Annual Lecture 2017.

Effective knowledge management for policymaking is essential for modernising the way the European Commission operates, overcoming silo mentalities and connecting synergies between portfolios, as envisaged by President Juncker and set out in the 2016 Communication on Data, Information and Knowledge Management. The growing complexity of the policy issues at stake and the increasing flood of data and information available require skills to make sense of the best available information and turn it into relevant knowledge for EU policies.

Knowledge management has long been an integral part of the JRC's work. It is not done in isolation, but intertwined with knowledge production in support of the organisation's core mission of providing policymakers with solid, credible evidence upon which policies can be designed and implemented. In 2016, the JRC adopted its strategy 2030, which formalised the growing importance of managing and making sense of the collective knowledge, not instead of, but in addition to producing it.

New JRC competence centres (CCs) (see below) have been created to develop, provide and apply analytical tools and methods to support the conception, implementation and evaluation of EU policies. Four knowledge centres (KCs) (see below) have been created so far, collectively involving 24 DGs and services. Two more KCs and one CC are in preparation and will be launched in the near future. While the CCs provide their tools for the policy problems at hand, the EU Policy Lab, a collaborative and experimental space to bring innovation in policymaking, has been created to combine foresight, behavioural insights and design thinking to explore, connect and find solutions for developing better policies.

## *Important achievements during 2017 include the following:*

- The release of a unified web portal, including an **Urban Data Platform** to support the urban agenda for the EU.
- A **dynamic data hub**, providing up-to-date data and analysis of migration flows, trends and impacts.
- A **'Social Scoreboard'** to accompany the European Pillar of Social Rights.
- Operating the corporate modelling inventory **MIDAS** and driving a community of practice on modelling.
- **Training courses** to equip people with the skills required for bridging the science–policy divide.
- The application of the **connected platform** in the European semester process.
- The launch of the **Megatrends Hub** — a dynamic collective intelligence system on a set of 14 megatrends, i.e. large-scale, long-term development trends that are observable now and could have significant influence on future processes and perceptions. It is being developed as a foresight knowledge management infrastructure to support thinking about the future and strengthening the anticipatory culture in the JRC and the Commission.
- The **JRC Annual Science Lecture** and **Conference** dedicated to debating the place of science in a post-fact society, where scientific evidence struggles to retain its position in sound policymaking due to the rapid circulation and uptake of unsubstantiated information.

Work on data management has intensified, with investment in innovative ways of deriving information and knowledge from the wealth of JRC research data and making it available to researchers, information professionals, entrepreneurs and the general public via the JRC Data Catalogue.

The JRC is strengthening its emphasis on providing a sound factual base for crucial debates by issuing its 'flagship reports', which bring salient points in a visually attractive and easily understandable way. They are top-quality, high-profile JRC outputs reflecting state-of-the-art scientific knowledge in response to high-priority political topics for the EU Institutions. In 2017, these reports were:

*What makes a fair society? Insights and evidence* which looks into long- and short-term trends in income inequality, how family background and geographical location affect labour market outcomes, and the associations between education and health, as well as issues of perceptions and attitudes.

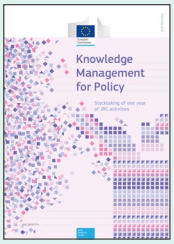
*Science for the AU-EU Partnership – Building evidence for sustainable development* describes three decades of collaborative work between the JRC and many organisations and institutions across Africa, focusing on the African dimension of the partnership and exploring the challenges and opportunities ahead.

*Science for disaster risk management 2017: knowing better and losing less* addresses the three distinct phases of understanding, communicating, and managing disaster risk, supporting the integration of science into informed decision-making.

The next few years will require still more innovation from the JRC, to deal with the challenges surrounding the use of scientific knowledge and experts for policymaking, and to advocate its use in the face of populist opposition to experts. New ways of communicating science to the general public and engaging with their concerns must be developed, considering the latest science of cognition and decision-making.

In this context, the JRC aims to become a global leader in the creation, management and application of knowledge for public policy, helping to address the concerns raised by the current 'post-fact' debate and leading the campaign for evidence-informed policy.

## *Knowledge Management for policy*

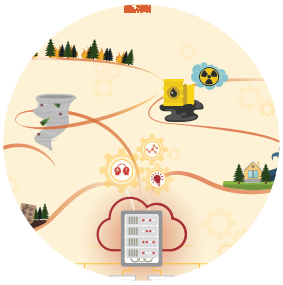



To learn more about these and other JRC knowledge management activities such as communities of practice, collaborative platforms, hosting, organising and sharing of data, knowledge repositories and services, we invite you to read our stocktaking report Knowledge management for policy which is accessible online on the JRC's Science Hub.

# *Knowledge and competence centres*


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 the quality of life of their citizens.


The Knowledge Centre for Migration and Demography (KCMD) provides stronger evidence and better knowledge for EU policies related to migration. In addition to supporting the European agenda on migration, the focus is on migration and demographic developments on a global scale and their societal impact on the EU in the medium to longer term.



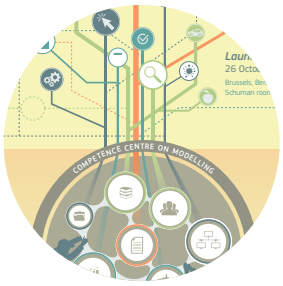
The Knowledge Centre for Disaster Risk Management (DRMKC) provides better knowledge, stronger evidence and a greater focus on transformative processes and innovation to improve our understanding of disaster risk, to build resilience and risk-informed approaches to policymaking, and contribute to smart,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

The Knowledge Centre for Bioeconomy (BKC) acts as a knowledge broker between policy DGs and knowledge producers. Its community of practice will help generate solid expert advice for urgent policy questions and its data repository and library will serve as a comprehensive information source, complemented by authoritative analyses.


The Competence Centre on Composite Indicators (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, micro-econometric analysis and counterfactual impact evaluation.


The Competence Centre on Text Mining and Analysis (CCTMA) addresses policymakers' need 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 needed: computational linguistic research, applied IT and support.




The Competence Centre on Modelling (CC-MOD) leverages modelling capacity and competences across the Commission 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.

# COLLABORATING WITH INTERNATIONAL PARTNERS

Effective collaboration with the European and international research community, as well as with institutions in partner countries, 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. This collaboration with international partners takes many different forms and shapes, as exemplified in this chapter. In 2017, the JRC continued fostering international and cross-regional cooperation with many partners, including China and Japan. Partnerships with EU Member States at national and regional levels were also reinforced, in particular with Poland, Slovenia and Finland. Cooperation in the nuclear field continued featuring high among the JRC's partnerships. The JRC undertook a review of its ongoing partnerships to take stock of ongoing collaboration and identify gaps and opportunities. This review led to a set of recommendations on strategic partnerships for the future.

## The JRC and Poland team up on nuclear safety research

On 3 February, the JRC and the National Centre for Nuclear Research (NCBJ) of Poland signed a collaboration agreement focusing on nuclear material research, security, and medical applications. The NCBJ research profile combines studies related to nuclear power with various fields of subatomic physics. Major products manufactured at the NCBJ include radiopharmaceuticals and a range of particle accelerators for scientific work, medicine and industry.

The new agreement will help to foster scientific excellence by pursuing common research and implementing the JRC education and training strategy.

The scope of cooperation includes material research, accelerator and detector developments, security, cogeneration from nuclear reactors, reactor safety analysis and medical applications. The first joint projects will start in 2018.

## A new impetus for scientific cooperation between the JRC and Slovenia

In February, the JRC and the Slovenian Ministry of Education, Science and Sport signed a memorandum of understanding to boost scientific cooperation. The memorandum opens new avenues for scientific exchange and synergies in the fields of energy, transport, public health, security, climate change, digital transformation and biotechnology, among others.

One area of focus will be the EU's macro-regional strategies for the Danube, Alpine and Adriatic–Ionian regions, with a focus on implementing and monitoring the smart specialisation strategy. Another area of emphasis for future joint scientific work is expected to be in the field of sustainability and resources, with a specific focus on marine and freshwater research, agriculture, forests, and raw materials.

Aalto University

## Strengthening scientific links with Aalto University in Finland

The JRC and Aalto University signed a memorandum of understanding which aims to boost scientific cooperation in a number of fields. The memorandum will enable knowledge exchange and scientific synergies in several areas of common interest, including advanced energy solutions, regional innovation and entrepreneurship. It opens new avenues for collaboration in the fields of sustainable use of natural resources, biomaterials, text and data mining, cyber security, quantum technologies, wireless communications (including 5G networks), improving quality of life in urban areas, and design-driven innovation.

Ahead of the signing, the JRC published a report on the innovation 'ecosystems' of Aalto University and the Espoo Innovation Garden. The report presents a case study identifying the key success factors of the ecosystems, with particular attention to the role of Aalto University as an example of an entrepreneurial university. The report finds that Aalto University is a strong orchestrating actor that has stimulated the collaborative, cross-cutting activities of others. One of the reasons for this success is the multidisciplinary thinking at Aalto.

The report aims to inform policies designed to support the strengthening and emergence of place-based innovation ecosystems and entrepreneurial universities in other EU regions and cities. Aalto University has six schools with nearly 20 000 students and 4 000 employees, 386 of whom are professors. It is a community where science and art meet technology and business.

AIST
NATIONAL INSTITUTE OF ADVANCED INDUSTRIAL SCIENCE AND TECHNOLOGY

## Japanese National Institute of Advanced Industrial Science and Technology (AIST)

The JRC and the Japanese National Institute of Advanced Industrial Science and Technology (AIST) signed a research framework arrangement aiming to boost cooperation and scientific excellence. The arrangement

opens new avenues for scientific exchange and synergies in several fields, including energy, chemicals, nanotechnology, metrology and measurement.

The arrangement builds upon prior cooperation between the JRC and AIST that has been developing for several years, focusing on the inter-laboratory testing of nanomaterials through in vitro tests, the harmonisation and standardisation of measurements and the development of new measurement standards.

中国科学院
CHINESE ACADEMY OF SCIENCES

## Chinese Academy of Sciences

The JRC and the Chinese Academy of Sciences concluded a research framework arrangement during the EU–China Summit in June. The new arrangement focuses on areas linked to the EU–China strategic agenda 2020 for cooperation, including air quality, renewable energy, climate, environmental protection, digital economy, smart specialisation and evidence-based policies.

The JRC also participated in the third EU–China Innovation Cooperation Dialogue, which took place in the margins of the summit, where it presented the ongoing cooperation and future activities with China's major scientific organisations. A joint technical workshop was held in May, at the JRC's Ispra site, to advance bilateral cooperation.

The new arrangement builds upon existing and longstanding successes with a number of Chinese institutes, especially the Institute of Remote Sensing and Digital Earth. In the field of disaster risk management, a China human settlement joint research project started in 2017 which develops advanced algorithms to map human settlements in China and globally with the help of satellite data. The two partners have been also collaborating on next generation spatial data infrastructures, known as Digital Earth.

## Western Balkans

The JRC is carrying out the initiative 'Enlargement and integration action' (E & IA), which provides scientific and technical support to H2020-associated countries and in particular to the Western Balkans. The E & IA adopts a holistic capacity-building strategy to support the transposition of the EU legal framework into national legislation and facilitate scientific and technical exchange.

In 2017, the JRC launched two coordinated actions aimed at the Western Balkans. The first is a 2-year pilot project supporting the development of smart specialisation strategies in Serbia and Montenegro. Also, the authorities in Albania and in the former Yugoslav Republic of Macedonia have already expressed their commitment to comprehensively analyse their economic fabric and involve all relevant stakeholders in prioritising Research &Innovation (R&I) efforts through smart specialisation. In parallel, the JRC has launched a second initiative, which aims to accelerate the technology transfer and innovation ecosystem in the Western Balkans by providing support in the areas of technology transfer office management; science parks and incubator creation and management; the exploration of new technology transfer related investment instruments; and access to finance for start-ups and SMEs.

In addition, the JRC organised an innovation camp in Serbia in December 2017. Innovation camps present a novel form of public administration/political outreach towards local and regional authorities and citizens at large. The event was focused on the analysis of ICT-related challenges and in particular ICT/software development, which is one of the relevant economic sectors in Serbia. Prototypes of scenarios and a roadmap for follow-up activities that will influence the industrial and social policies of the software industry have emerged as a result of the participatory co-creation process within the innovation camp.

## Collaboration with Ukraine on smart specialisation strategies

The JRC collaborates with Ukrainian authorities to foster inclusive and sustainable economic growth through innovation strategies based on the smart specialisation methodology, which is used by over 180 regions in Europe. It links different socioeconomic sectors to help regions identify a number of priority areas for R & D investments, focusing on their strengths and comparative advantages.

The methodology is based on stakeholder involvement, open participation mechanisms, a mix of policies and constant monitoring and update. It underpins investments aimed at strengthening research, technological development and innovation, and is supported by the EU's regional development policy.

The Smart Specialisation (S3) platform managed by the JRC has been functioning across Europe since 2012. The project kicked off in Ukraine as a pilot focusing on a limited number of regions. So far, it has involved awareness-raising events, training activities and a mapping of Ukrainian economic, scientific and innovation potential.

## Latin America

On 15 March 2017, more than 100 participants from Latin America and the EU took part in the launch event of the JRC study on innovation and regional specialisation in Latin America, organised in Brussels. The event was a good opportunity to present the key findings of the study and to show examples of the cooperation on smart specialisation between EU and Latin American practitioners, such as the Brazilian state Pernambuco and Portuguese Region Oporto (modernisation of the automotive and textile sectors), the Basque Country and Colombian stakeholders from the Bogota Region (common energy clusters) or the Chilean government and the Finnish Region Ostrobothnia (bioeconomy and energy). The JRC has developed a strong bilateral cooperation with Brazil, based on the collaboration arrangement with the Brazilian Ministry of Science, Technology, Innovation and Communication (MCTIC) signed in January 2013, due for a 5-year renewal in January 2018. The JRC supported setting up Brazil's National Centre for Natural Disasters Monitoring and Alerts and pursued cooperation within the Global Flood Partnership and the Global Flood Awareness System. In 2017, several Brazilian projects to which JRC is a partner were selected for funding under the EU-Brazil Sector Dialogue Support Facility (circular economy and life cycle assessment, smart specialisation, Brazil–Europe collaboration on natural disasters and innovation in the public sector).

The JRC has also cooperated closely with Mexican institutions. Two representatives from the Iberoamericana University Puebla (Ibero) visited the JRC site in Ispra in June 2017 to explore how the JRC could help in establishing a new PhD program on engineering and economics.

An Argentinian delegation from the National Scientific and Technical Research Council of Argentina visited the JRC Headquarters in Brussels in March 2017 to discuss a short-term exchange of staff to share experience on knowledge transfer, research and innovation funding, and possibly applying the smart specialisation concept in Argentina.


## Macro-regional strategies

The JRC has been providing strategic scientific support to macro-regional strategies has been an important activity for several years.

At the beginning of 2017, a report, Connecting and mobilising for a joint response to common challenges, illustrated the JRC's scientific support in the EU strategy for the Danube region. The JRC's support role in the EU strategy for the Danube region implied regular contact and meetings with representatives of the different European Commission DGs involved in cooperation related to macro-regional strategies. During 2017, the JRC participated in the development of the *Study on macro-regional strategies and their links with cohesion policy*. In this context the JRC took part in several related events in 2017, including the EU Strategy for the Danube Region sixth Annual Forum in Budapest.

# REACHING OUT TO STAKEHOLDERS AND CITIZENS AT LARGE

The JRC strives for scientific excellence, one important element of which is constituted by our ability to share knowledge and information with our partners and the broader outside world. As a multi-disciplinary organisation, the JRC works with a great variety of stakeholders: policymakers at all levels of government, from international to local, but also 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. It is a key role of the JRC to engage and share knowledge and expertise with the widest possible audience.

In 2017, activities that contributed to these core aspects of the JRC's mission included targeted initiatives such as the open access to JRC research infrastructures initiative, the collaborative doctoral partnership (CDP) scheme, or the science meets parliaments/regions schemes. As in previous years, events, media outreach, social media interaction and publications also played their role.

## Open access to JRC research infrastructures

In 2017, the open access to JRC research infrastructures initiative was launched. It allows the research community, public authorities and industry in EU Member States, candidate countries and H2020-associated countries to make use, under certain conditions, of our unique facilities.

Offering access to visiting researchers is part of the JRC's strategy to enhance dissemination of scientific knowledge, boost competiveness, bridge the gap between research and industry and provide training and capacity building. Two different modes of access are provided.

**Relevance-driven access** is mainly granted to universities, research institutions and SMEs, possibly in association with industry and private organisations, in areas relevant to the JRC's strategic priorities and of importance for European standardisation, integration and cohesion, sustainable growth and competitiveness. Access is based on a peer-review selection process following a call for proposals.

**Market-driven access** is granted upon payment of a fee covering the full access costs of the JRC, and it is mainly targeted at industry. Projects are selected by placing emphasis on strategic importance at EU level.

In 2018, the JRC is offering, through public calls, access on a pilot basis to the Nanobiotechnology laboratory, the Reaction Wall and the Hopkinson Bar Facility of the European Laboratory for Structural Assessment (ELSA), and to four research infrastructures for nuclear reaction and decay data measurements. The pilot will gradually be extended to include another 41 laboratories.



## Collaborative doctoral partnerships

At the end of 2016, the JRC launched a new CDP scheme in cooperation with universities from the EU Member States and H2020-associated countries. The scheme offers opportunities to a new generation of doctoral students, with particular focus on research for policymaking.

Through the CDP, the JRC seeks to establish strategic collaborations with universities that have an international reputation in science and technology and provide doctoral studies. Students will be able to work at the science–policy interface, gain an understanding of research needs at different stages of the policy cycle, and learn how to communicate science more effectively.

The partnerships should also lead to strengthened collaboration between the JRC and universities by promoting mutual enhancement of related skills and competences, combining knowledge, capacities, and networking in key scientific areas.

In the pilot phase of the project, six thematic areas have been identified: energy and transport modelling, soil and land use change, bio-economy and forests, machine learning, genomics and bioinformatics, and nuclear decommissioning and waste management.

134 eligible applications from 74 higher education institutions in 22 EU Member States and three H2020-associated countries were received in response to the call for expressions of interest.

# *Science meets Parliaments*
# *Science meets Regions*

The traditional 'Science meets Parliaments' event in the European Parliament was held on 28 November 2017, marking the successful conclusion of the third edition of the scheme that regularly brings together scientists and policymakers to strengthen the dialogue and further promote a culture of evidence-informed policymaking.

The event, organised by the JRC together with the European Parliament's Science and Technology Options Assessment gathered Members of the European Parliament, policymakers from the EU institutions, Member States, national parliaments, regional authorities, scientists and representatives from academies and universities to discuss the role of science in a post-fact society. Within this framework, different thematic panels also explored the importance of art and science for innovation and gave young scientists from EU Member States the opportunity to challenge MEPs. The day also marked the launch of the sixth MEP–scientists pairing scheme, with 17 pairs of MEPs and scientists, including two from the JRC.

The following day, 29 November, the Committee of the Regions hosted 'Science meets Regions', wrapping up the regional leg of the scheme and discussing how to maximise the impact of science for regions and cities in current and future EU policies. The discussion also touched on the role of science in the next EU multiannual financial framework. It gave the opportunity to regions that had already hosted local events within the 'science meets regions' scheme to share their experiences and best practices, reflecting on the importance of regional partnerships and **research and innovation strategies for smart specialisation** at local level for public authorities, academia, business and citizens.

"Science meets Regions' and 'Science meets Parliaments' events also took place on a wide range of topics throughout the year across Europe. These were organised jointly by the JRC and regional and national authorities. Smart specialisation was the focus of the events held on 4 May in San Sebastian (Spain) and on 16 November in Gabrovo (Bulgaria), while the event hosted in the Slovenian Parliament in Ljubljana on 11-12 October debated R & I challenges for the country. On 14 November in Murcia (Spain) scientists and local experts discussed water management and energy in the Mediterranean, and on 20 November relevant stakeholders met in Dresden (Germany) to exchange insights on energy and climate-change issues. A 'Science meets Parliaments' event also took place on 6 December in Bratislava discussing the proposal for the establishment of a Subcommittee for the Future within the National Council.

Together, these events saw the involvement of nearly a thousand policymakers, scientists, stakeholders, regional authorities, businesses and citizens and led to a much better mutual understanding between science and policymaking, also enhancing the ability of the JRC to efficiently communicate scientific content to policymakers.

## Fostering greater collaboration at national, regional and local level

In 2017, the JRC released two complementary publications aimed at raising awareness and promoting collaboration with stakeholders at national, regional and local levels.

The *Practical handbook for regional authorities* serves to explain how to use existing JRC knowledge, information and tools to support the work of local and regional authorities. It does so through 37 factsheets which contain practical advice and concise descriptions of products and tools relative to specific policy areas such as energy and transport, environment, research and innovation and crisis management and resilience.

*JRC services, a handbook for national, regional and local authorities on why and how to engage with the European Commission Science and Knowledge Service* provides a broader overview of the JRC's science-for-policy capabilities and how they can be used to assist national and regional policymakers in achieving their goals. Services are presented both in a thematic manner covering different policy areas, and in a more generic manner describing access to data and research infrastructures, education and training and certified reference materials. The handbook is primarily directed at government personnel in the EU Member States and H2020-associated countries, but can also be of interest to national and regional science organisations and academics.

Both publications were distributed broadly and triggered a lot of interest from the Member States. They help reinforce the JRC's existing partnerships and establish new ones. They also help to fulfil one of the JRC's key strategic objectives, namely to bring our activities closer to the Member States and strengthen our collaboration.

## Evidence & Policy Summer School

The third edition of the annual JRC Evidence & Policy Summer School was organised in Slovakia, in partnership with the Slovak Academy of Sciences and the international network for government science advice. Each year a selected policy area brings researchers and policymakers together to learn skills for knowledge management for their policy expertise. For 2017, migration and demographic change were the focus.
The three-day training and networking event focused on the practical skills for evidence-informed policymaking, organised with trainers from leading organisations dedicated to bridging the gap between science, policy and society: the European University Institute, the Centre of Migration Research of the University of Warsaw and the International Institute of Social History, as well as the JRC Knowledge Centre on Migration and Demography, the JRC Centre for Advanced Studies and partner organisers.

The event was attended by 70 researchers and policymakers working in this topic, coming from 22 EU Member States and neighbouring countries from central and eastern Europe. Feedback from the participants indicated that the experience shared by the JRC was highly appreciated and found to be of practical use.


## *Science for policy at the world's largest science conference*

The American Association for the Advancement of Science is the world's largest general scientific society, and publisher of the journal *Science*. In 2017, during the annual meeting in Boston, the JRC presented its scientific support to EU policymakers in delivering a Europe that protects, empowers and defends. This was illustrated by showcasing some key activities such as combating nuclear terrorism, stimulating policy innovations and strengthening European scientific advisory structures.

The JRC participated in several scientific sessions at the American Association for the Advancement of Science to look into different practices in which evidence informs policy, such as global nuclear terrorism, where international efforts are indispensable.

The JRC's Global Surface Water Explorer was presented as an example of how scientific evidence can serve the interests of humanity.

## *Communication activities*

The JRC's communication activities help the organisation achieve its goals and 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 **2070** publications have been produced:*

**838**
Books and articles in peer reviewed journals*

**1217**
Scientific, policy and technical reports

**15**
PhD Thesis

* Books, monographs with JRC editorship, article contribution to a monograph, article contribution to peer-reviewed periodicals listed in the ISI Science Citation Index Expanded and/or Social Science Citation index, article contribution to other periodicals.

## Social media

*In 2017, the JRC has achieved:*

Over **5 million** impressions and 80K engagements on Twitter

Over **3 million** impressions and 28K engagements on Facebook

Over **3.5 million** impressions and 40K engagements on LinkedIn

**91k** views on YouTube

## Media

**118** JRC web news pieces publish

Record year for news coverage: over **4000 articles** mentioning the JRC

Nearly **20k** JRC newsletter subscribers

## Events

**46** events gathering from 50 to 2000+ participants, including **28** high level events

Nearly **5000** participants mobilised in total

# BOARD OF GOVERNORS' HIGHLIGHTS

The JRC Board of Governors assists and 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. Mostly seasoned professionals of the science–policy interface, former ministers and high-ranking civil servants, or eminent academics from renowned universities, the Board members closely follow JRC progress as reported by our Director-General and, in turn, give advice and inform JRC management about relevant national developments. When justified, dedicated ad hoc working groups are created for more in-depth scrutiny and better understanding by the Board as a whole. In 2017, two ad hoc groups were active: the Ad Hoc Group on the Implementation of the JRC Strategy 2030 and the Ad Hoc Group on the JRC Work Programme 2018-2019.


## *The year of activities in the Board*

The Board met on four occasions in 2017: three regular meetings and one extraordinary meeting.

**The first meeting** of the year was held in March in Geel. It was the occasion for the Ad Hoc Group on the Implementation of the JRC Strategy 2030 to present its most recent observations and recommendations, and its mandate was renewed for an additional year. Board members also gave input to thematic presentations on ongoing collaboration between the JRC and the European Institute of Innovation and Technology, JRC Data 4 Policy, and technology transfer activities. An update on the interim evaluation of the Euratom research programme and a presentation on the opening of research infrastructure were also presented and discussed by the Board.

**The second meeting** of the Board took place in June in Ispra. The Ad Hoc Group on the Implementation of the JRC Strategy 2030 presented its opinion on the status of the implementation of the strategy. The results of the interim evaluation of the Euratom research programme were presented. Topics of the thematic presentations which were discussed included alternative methods for animal testing, sustainable transport and energy efficiency, and the activities of the Competence Centre on Text Mining and Analysis. The Board members also gained insight into the ongoing collaboration between the Lombardy region and the JRC in Ispra, which was presented by an external speaker from the regional authority.

**Coinciding with the 2017 Annual Lecture and Annual Conference, an extraordinary meeting** of the Board was organised in September in Brussels as part of the events to celebrate the JRC's 60th anniversary. Keynote addresses provided an interesting 360° stakeholders' survey. Herbert Allgeier and Dominique Ristori, both former Directors-General of the JRC, gave an historical perspective. Sir Peter Gluckman, Chief Science Advisor to the New Zealand Prime Minister, shared his perception as an external collaborator of the JRC. Mark Ferguson, Chief Scientific Adviser to the Government of Ireland and member of the Board, gave a national perspective. Markku Markkula, Vice-President of the European Committee of the Regions, brought in the local and regional dimension. Patrick Cunningham, Chair of the evaluation panel for the mid-term evaluation of JRC in H2020 and of the panel for the *ex post* evaluation of JRC activities in the seventh framework programme shared his impression, from accompanying the JRC's evaluation process, that the JRC is on the right track to become more efficient and successful in a constantly changing environment. Lowri Evans, Director-General of DG Internal Market, Industry, Entrepreneurship and SMEs, spoke from a policy DG partner perspective, highlighting the growing importance of the JRC for underpinning the work of a policy DG. Bjorn Stigson, former President of the World Business Council for Sustainable Development, completed the stakeholders' horizon with his views on the role of industry's interaction with the European Commission and the JRC in particular. Hervé Bernard, the Board member of France, presented his thoughts about the central role of scientific advice for a democratic society in Europe. A short film with testimonials from the JRC's external partners was screened and warmly welcomed by the audience. Concluding the meeting, JRC Honorary Award winner Jean-Paul Malingreau presented insights on his personal experiences of working at the JRC, and 24 members of the JRC were awarded the newly founded Prize Award for JRC Fellows for their outstanding work and careers at the JRC.

**The last Board meeting of the year** was held in November in Karlsruhe. The Ad Hoc Group on the Implementation of the JRC Strategy 2030 presented its latest observations and recommendations. Thematic presentations were given on resilience and on the activities of the Knowledge Centre for Territorial Policies. Björn Stigson, Chairman of the industry panel which evaluated JRC industry relations, presented the findings of a study looking at non-Euratom activities. The Board also provided a favourable opinion on the JRC work programme 2018-2019 and the draft budget for 2018.

# Science for policy highlights

The following chapters provide a series of examples of what the JRC has achieved in 2017 through the prism of the Commission priorities.

# A new boost for jobs, growth and investment

Collective and coordinated efforts at European level continue to be needed to put Europe on the path to renewed economic prosperity. As the first of the 10 Juncker priorities, Commission work in this area covers a variety of policies, a number of which the JRC contributed to in 2017.

Bringing concrete evidence of the potential of cultural and creative sectors, supporting the simplification of the common agricultural policy, tackling important knowledge needs on environmental questions and the circular economy, contributing to maritime and fisheries priorities and promoting good health and food safety are all examples of Commission activities that the JRC supported with its expertise in 2017.

## THE CULTURAL AND CREATIVE CITIES MONITOR IDENTIFIES STRENGTHS AND OPPORTUNITIES ACROSS EUROPE

The very first edition of the Cultural and Creative Cities Monitor covers 168 cities in 30 European countries and measures cultural and creative performance, capturing the positive effects on jobs, growth, and well-being. The monitor helps policymakers in the cultural sectors to identify local strengths and learn from comparable cities.

As an interactive online platform, it was built around three key indices: the cultural vibrancy, the creative economy and the enabling environment of a city. These are measured through 29 indicators, which include things like the number of museums and concert halls, patent applications in information and communication technologies, and the level of trust people have towards other citizens in their city.

The monitor shows that the 'ideal' cultural and creative city in Europe would have the cultural venues of Cork (Ireland); the knowledge-based jobs of Paris (France); the innovation of Eindhoven (Netherlands); the new jobs in creative sectors of Umeå (Sweden); the education of Leuven (Belgium); the tolerance and trust of Glasgow (UK); the international connections of Utrecht (Netherlands); and the quality of governance of Copenhagen (Denmark).

The monitor helps place culture and creativity at the heart of the EU policy agenda. Economic and other data from Eurostat and the Eurobarometer indicate that leading cultural cities perform better than their counterparts with similar populations.

## EUROPE'S FIGHT AGAINST CANCER: WAGING BATTLE WITH LEADING RESEARCH

In 2017, the JRC sought to address the prevailing breast cancer information gap, publishing an interactive online European map with information on screening, diagnosis, treatment and follow-up care for 35 countries. These Europe-wide snapshots form part of efforts to support the EU and Member States in securing equal access to high-quality care across the continent. The factsheets highlight the progress of each country in implementing the evidence-based guidelines provided by the European Commission initiative on breast cancer.

Each country's profile indicates the number of breast cancer diagnoses and deaths per 100 000 people, alongside the EU average. The level of participation in screening procedures is also detailed, as well as quality assurance schemes in place and health expenditure as a percentage of GDP.

Breast cancer is the most common type of cancer in Europe, with a growing number of diagnoses. The good news is that countries like Portugal and Malta have a relatively high survival rate, even though the cost of care is relatively low.

Germany and Austria have similar rates of survival but a higher cost of treatment.

Also in the fight against cancer, JRC scientists and the University Hospital Heidelberg presented research describing the results of the first in-human study of targeted alpha therapy of metastatic castration-resistant prostate cancer in 42 patients. For more than two decades, scientists at the JRC's Karlsruhe site have been developing targeted alpha therapy, which has been successfully used to treat different cancers.

The research won the 2017 Marie Curie Award of the European Association of Nuclear Medicine. The prestigious award recognised it as the best study out of 2 058 contributions. This is the third time that a study co-authored by JRC authors Alfred Morgenstern and Frank Bruchertseifer has received the accolade.

## A NEW SCIENTIFIC YARDSTICK FOR THE EARLY DIAGNOSIS OF ALZHEIMER'S DISEASE

In 2017, the JRC successfully developed a certified reference material (CRM) to support the early detection of Alzheimer's disease. The CRM will serve to calibrate tools to detect levels of amyloid-β 1-42, a biomarker for Alzheimer's disease which is found in cerebrospinal fluid. Reliable measurements support earlier and more accurate diagnoses, and could bring forth the development of new drugs for treatment.

The JRC produced the reference material in close cooperation with the International Federation of Clinical Chemistry and Laboratory Medicine, with support from the Alzheimer's Association. The CRM is an important step to one day containing the disease.

Research focusing on the very early stages of Alzheimer's disease is important, as clinical results have shown that a combination of biomarkers amyloid-β 1-42, tau and phospho-tau have a promising potential for early diagnosis. Levels of these markers in the cerebrospinal fluid begin to change up to 10 years before the first symptoms of the disease occur.

## PROCUREMENT OF FOOD FOR HEALTH: HALTING THE RISE OF CHILDHOOD OBESITY

Nutritious diets and the promotion of healthy lifestyles are vital to the positive development of children and adolescents. In the EU, 15 % of children and youth are considered overweight and 5 % are obese.

In 2017, the European Commission and the Maltese Presidency introduced a resource to support public procurement authorities for Member State schools to design contracts that ensure healthy food is provided to pupils across the EU. Based on JRC recommendations from a 2014 mapping of national school food policies, a report entitled Public procurement of food for health: technical report on the school setting provided support to the EU High Level Group on Nutrition and Physical Activity and offered technical guidance on translating school food standards into adequate procurement contract language.

The report covers key food groups including fruit and vegetables, meat, dairy products, cakes, saturated fat, salt, carbohydrates, sugar, micronutrients and vitamins. It also includes specifications for food preparation and catering services in general, and could pave the way for similar publications in other settings, including homes for the elderly, hospitals, work canteens and prisons.

The Maltese Presidency also collaborated with DG Health and Food Safety to provide the European Commission with an overview of the EU action plan on childhood obesity (2014-2020), promoting further work for a healthy lifestyle starting from childhood.

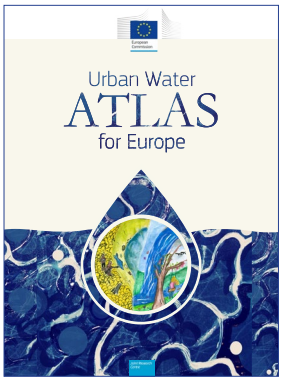
## TOWARDS WATER SUSTAINABILITY: URBAN WATER ATLAS FOR EUROPE

In April 2017, the European Commission published the Urban Water Atlas for Europe. This groundbreaking publication is a collaborative work between the JRC and four other European scientific institutes. The publication shows how different water management choices — and factors such as waste management, climate change and our food preferences — impact the long-term sustainability of water use in our cities.

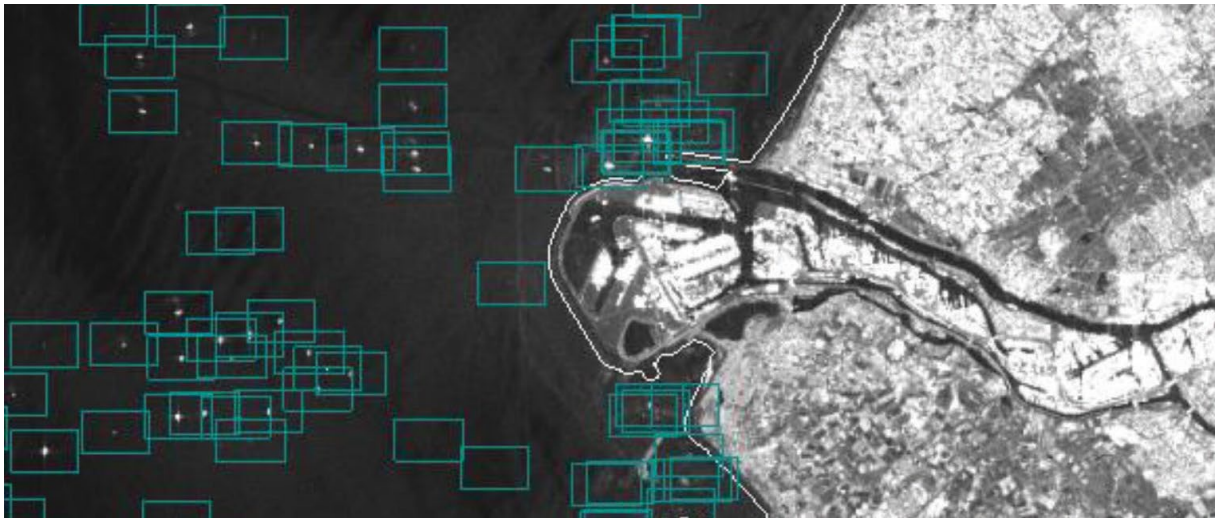
The new atlas informs citizens, local authorities and experts about the vital role of water in European cities. It highlights good practices and cutting-edge developments towards water sustainability. Detailed factsheets present the state of water management in more than 40 European cities and regions, together with a number of examples from further afield.

The work was funded by H2020, the EU's research and innovation programme. The launch of the atlas coincided with the meeting of ministers in charge of water management from the 43 members of the Union for the Mediterranean, hosted by the Maltese Government in Valetta.

The atlas comes with two online tools that can help cities manage water more sustainably. The City Blueprint is an interactive tool that supports strategic decision-making. The City Amberprint is a tool for assessing a city's progress towards becoming smart and sustainable.




**The Urban Water Atlas for Europe shows how water management choices and other factors impact the long term sustainability of water use in our cities.**



The JRC-developed SUMO software package enables ship detection on satellite SAR (Synthetic Aperture Radar) images.

## SUPPORTING FISHING AND MARITIME POLICY IN THE MEDITERRANEAN SEA

JRC work in the field provides warnings about pressures that might push the ecosystem and fish stocks beyond the point of no return. The JRC analysed the Scientific, Technical and Economic Committee for Fisheries' Mediterranean stock assessment data, and found that 93 % of assessed fish stocks are overexploited.

An estimated 10 000 to 12 000 marine species inhabit the Mediterranean Sea. This extraordinary biodiversity is also threatened by pollution and climate change; both the habitat and its fish stocks are in decline. The bigger the fish — such as sharks and rays — the more susceptible they are to increasing dangers, including overfishing and slow maturity. Over the past 50 years, 41 % of marine mammals and 34 % of the total fish population have been lost.

In order to help sustainability, a maritime surveillance tool, the Search for Unidentified Marine Objects, has been released. The JRC developed, tested and validated the software for the tool, which automatically scans large numbers of satellite images for the presence of ships. The results can be cross-checked with other maritime data to identify suspicious vessels. It is instrumental in helping to fight illegal oil dumping and illegal fishing.

The efforts of the JRC, in cooperation with other scientific organisations around the world, are contributing to the positive economic trends outlined in the 2017 Annual economic report on the EU fishing fleet. The fleet registered net profits at a record high of EUR 798 million in 2015, and estimates for 2016 and 2017 point towards further profits. Nevertheless, the report also confirms that economic performance stagnates where fleets depend on stocks which are still subject to overfishing. For example, the small-scale coastal fleets operating in the Mediterranean and Black Seas are prone to poor economic performance.

## TRACKING INVASIVE ALIEN SPECIES BY SMARTPHONE

Alien species are animals and plants introduced by accident or deliberately into a natural environment where they would not normally be found. A small proportion of these become invasive, with significant negative consequences for their new environment, thereby causing millions of euros' worth of damage every year.

Member States work to prevent their introduction by using early detection mechanisms for new appearances and adopting measures for those which are already widespread.

To support these efforts, the JRC has published the first ever baseline distribution of invasive alien species of Union concern, and launched a dedicated smartphone app to help monitor the animals and plants concerned. 37 invasive alien species have been prioritised to be dealt with at the level of EU territory and the app contains detailed information and photos of each of these.

Anyone can download it for free and use it to spot these animals or plants in the environment. Through their phones' GPS systems they can send information about species' locations, including photos, via the app. Data collected by citizens will enrich the maps included in the app. The data generated can also feed into the respective national surveillance systems throughout the EU.

Plenty of information is already available regarding alien species in Europe, but it is generally scattered across many different information systems and databases in various data formats. The JRC has created the European alien species information network to address this issue. The network is the official information system that supports implementation by the European Commission and the EU Member States of Regulation (EU) No 1143/2014 on invasive alien species.

## IDENTIFYING AND ELIMINATING MARINE AND RIVERINE LITTER FROM THE ECOSYSTEM

Marine and riverine litter is a threat not only to the ecosystem, but also to the economy and to human well-being. JRC research highlights the harmful direct and indirect impacts of litter in waterways and oceans, and provides recommendations to EU Member States on how to monitor and identify sources of litter that reach the sea.

Records show that both marine and riverine litter is dominated by plastic items. These can be transported by currents over long distances, and are found throughout the environment, even in remote areas and the deep sea. Millions of animals that live in the oceans are mutilated and killed by marine litter every year. Wildlife becomes entangled in or ingests the litter, both potentially leading to fatal outcomes (in 80 % of reported cases entanglement leads to death). Marine litter also has important implications for human welfare, through losses to economic sectors including tourism, fisheries, navigation and energy.

An understanding of how much litter enters the seas from different rivers can help in planning how to address the problem. However, harmonised methodologies are needed in order to provide quantitative data for comparable assessments. The Marine Strategy Framework Directive (MSFD) recognises that marine litter must be dealt with. The MSFD Technical Group on Marine Litter has published a report on Riverine litter monitoring — Options and recommendations. The JRC used these findings in its own project when establishing a pan-European monitoring network. The technical group provides evidence-based policy advice for the Member States. It has Europe-wide expertise, and is co-chaired by the JRC.

## THE REAL VALUE OF NATURE'S WATER PURIFICATION ECOSYSTEM

Water for drinking, home and public use — as well as for agriculture and industry — is provided for free by mother nature or, as scientists and policymakers put it, by ecosystem services. A study led by the JRC in 2017 puts the benefits of this 'free' service at EUR 16 billion a year at European level, a conservative estimate in terms of actual consumption by economic sectors and households.

The study examines in-stream nitrogen retention to gain a more holistic picture of the actual value of water ecosystems. Nitrogen is the leading cause of water pollution in Europe, with more than 50 million tonnes entering European river basins from 1985-2005. Rivers 'purify' the water by retaining much of the nitrogen that flows into them.

The full value of this water purification service in Europe is worth up to EUR 31 billion per year. However, for almost all European countries, in-stream nitrogen retention occurs at unsustainable levels, and river ecosystems are progressively degrading as a result of nitrogen pressure.

The authors of the study provided, in 2017, the first ever economic evaluation of ecosystems' water purification across Europe, based on the System of Environmental Economic Accounting — Experimental Ecosystem Accounts. This is an experimental tool developed by the European Commission and other major global institutions. Ecosystem accounting aims to monitor the capacity of the natural environment to sustainably deliver its multiple services.

## SCIENCE FOR AN EVOLVED COMMON AGRICULTURAL POLICY

The JRC's scientific insight helps policymakers understand the scope and impacts of potential efforts to ensure that the common agricultural policy (CAP) is fit for today's world: a policy that is focused on meeting the challenges of a fair standard of living for farmers, preserving the environment and tackling climate change — as outlined in the Commission's November 2017 communication on the future of food and farming.

JRC scientists applied three exploratory scenarios to characterise future visions for the CAP up to 2030. The 'no-CAP' scenario — removing all budgetary support to farmers — could lead to a strong decline in farming income by 2030, job losses and a return to the EU being a net importer of agricultural products. The study emphasises that whatever policy choices are made, smaller farms are likely to be more heavily impacted by changes to regulations and subsidies.

The study also considers an 'income and environment' scenario: maintaining the CAP budget at its current level with stricter environmental rules, which could result in an overall higher income (with some job losses) while avoiding an increase in greenhouse gas (GHG) emissions; and a 'liberalisation and productivity' scenario: a strong reduction in subsidies and a shift to productivity-increasing measures and further trade liberalisation, which could lead to a drop in farming income, job losses and agricultural production.

The analysis of the various options made use of the JRC's iMAP platform models Magnet, CAPRI and IFM-CAP in an integrated manner, covering spatial scales from the global right down to individual farm level.

## IMPROVING THE TRANSPARENCY AND RELIABILITY OF INTERNATIONAL AND DOMESTIC ECONOMIC ANALYSES

Reliable data is vital for high-quality, research-based policy support. In 2017, a team of colleagues working cross-directorate within the JRC produced a significant contribution to improving the quality of data supplied to the EU-global trade analysis project (GTAP).

The GTAP is a global network of 15 000 researchers and policymakers in 170 countries conducting quantitative analysis of international policy issues. The centrepiece of the GTAP

is a global database on trade, production, consumption and intermediate use of commodities and services.

The so-called GTAP Input-Output database is widely used in the analysis of agricultural policies and energy and climate issues, as well as the water/energy/land nexus. It also constitutes a key input for JRC models like the GEM-E3 and Magnet models. As such it supports the impact assessments of a number of the European Commission's Directorates-General, including DG Climate Action, DG Agriculture and Rural Development, DG Energy, DG Environment, DG Trade and DG Regional and Urban Policy, to name a few.

This calls for consistently linking the GTAP database with official national statistics and making sure that the GTAP database has enough high-quality statistics to address such policy analyses. To achieve this, the JRC team of the EU-GTAP project developed a new conversion method for the whole of the European Union that guarantees that the EU data supplied to the GTAP database complies with the latest statistical standards (European System of Accounts — ESA2010) and is consistent with Eurostat official statistics (for the year 2010) and recommendations for the estimation of missing data.

The increased quality of the EU data in the GTAP database greatly contributed to improving the transparency and reliability of international and domestic economic analyses carried out at the JRC. This work also allowed the European Commission to be in compliance with Court of Auditors' recommendations from its 2014 audit.

## THE AIR QUALITY ATLAS FOR EUROPE

The JRC's 2017 Air Quality Atlas for Europe screens the emission sources responsible for the levels of 'particulate matter' (PM) in Europe's largest cities. The term refers to fine solid or liquid particles, such as dust, smoke, soot, condensing vapours and soil particles. PM2.5 — particulates with a diameter smaller than 2.5 µm, can reduce life expectancy. As a result of poor air quality in the EU every year, about 400 000 citizens die prematurely — 10 times more than the deaths caused by road traffic accidents.

The Air Quality Atlas also provides information on the type and location of the main emission sources leading to the formation of particulate matter in the air. It describes 150 European cities with a population density above 1 500/km2. The pollution of many of these cities exceeds the air pollutant levels recommended by the EU and the World Health Organisation.

The cities with the highest particulate pollution in Europe are located in southern Poland, the Italian Po Valley and Bulgaria. Transport emissions contribute heavily to PM2.5 levels in cities like Madrid (where 39 % of PM2.5 comes from transport), Luxembourg City (30 %) and Paris (29 %). Although agricultural activities take place mostly outside cities, emissions from these activities do contribute to fine particulate matter concentration in many European cities, with the highest levels from this source being found in Germany and the Czech Republic. Industry is a major air polluter in some of the eastern countries as well as in the western part of Germany.

## FINDING ALTERNATIVES TO ANIMAL TESTING IN PREVENTING SKIN ALLERGY

The JRC's EU Reference Laboratory for Alternatives to Animal Testing (EURL ECVAM) continued leading in its field in 2017 with the publication of research recommendations promoting the scientific and regulatory acceptance of non-animal tests to evaluate skin allergy. This included two new skin sensitisation tests and defined approaches based on the integration of different kinds of non-animal data.

The new defined approaches for skin sensitisation testing have comparable performance to the standard animal local lymph node assay test, which is used for identifying potential skin allergens. In addition, they can provide useful information to distinguish between strong and weak sensitisers. In light of this, the EURL ECVAM recommends that the defined approaches be used instead of local lymph node assay test data where applicable and adequate.

The EURL ECVAM assesses international standards in the characterisation of chemicals that have the potential to cause allergic reactions to the skin. Among its achievements since being formally established in 2011, the laboratory can be credited with the development and recommendation of the first three non-animal in vitro methods, adopted by the Organisation for Economic Cooperation and Development (OECD). The EURL ECVAM also led the development of international guidance on reporting harmonisation.


**JRC research recommendations promote the acceptance of non-animal tests to evaluate skin allergy risks.**

# A connected digital single market

The internet and digital technologies have a huge transformational impact on our economy and society. However, fragmentation and barriers in digital services across the EU reduce the chance of reaping the full benefits of the digital economy in the EU single market. The digital single market strategy was launched as a set of 16 important initiatives tackling the various obstacles and opportunities to the digital transformation.

The JRC is supporting the Commission in shaping and implementing these initiatives aimed at ensuring that Europe's economy, industry and employment take full advantage of what digitisation offers, breaking down barriers to cross-border online activity, supporting e-infrastructure development and designing rules/guidelines which match the pace of technological evolution.

## PROTECTING CHILDREN AND ADULTS ONLINE

The European Commission promotes safer internet through the better internet for kids strategy. JRC scientists have created an educational game, Happy Onlife, to assist with the safe use of information and communication technologies. A set of resources are used to raise awareness about online safety risks which may seriously affect a child's life, such as privacy and cyberbullying.

The game comes in two formats. The paper version is currently available in English and Italian, and the digital version is available in five EU languages: Spanish, English, French, Italian and Dutch. Happy Onlife also went mobile in 2017, with availability for iOS, Android and Windows smartphones, and its source code is publicly available. Interested parties may develop and improve it, according to their own needs.

In a similar theme, the JRC published a new report, *Internet of toys: Safety, security, privacy*, where scientists invite parents to learn about the functions, security measures and privacy settings of internet-connected toys that have been manufactured for children. Parents are advised to focus on the quality of play by observing their children and playing alongside them.

Adults who purchase online goods could be offered help thanks to another JRC study that showed that gentle website 'nudges' could be the key to avoiding unwanted or mistaken purchases. The JRC conducted an experiment with 626 participants to learn how they react to different kinds of online warning messages when purchasing online products. Messages aimed at the customer's emotions, combined with an emoticon (a sad face), were found to be the most effective in preventing a participant from misguided online purchases.

## A COMPREHENSIVE GLOBAL ANALYSIS OF ICT INDUSTRIES

The JRC report *Prospective insights in ICT and R & D* provides the most complete worldwide analysis available on the information and communication technology industries. It focuses on 40 advanced and emerging economies, including the EU-28 plus Norway, Russia, Switzerland, and nine other major economies. It contributes to the Commission's annual Europe's digital progress report.

The analysis finds that although the EU is making steady progress through the digital single market strategy, the gap between top performing countries like Finland, and less well performing ones, like Romania, is too large. With 5.7 million people employed in ICT in 2014, the EU ranked third in the world in terms of value added to the economy. Its rank was challenged by the spectacular progression of China, which was second only to the United States. At global level, close to 25 % of total business expenditure in R & D originates from the ICT sector. At the EU level it is 16 %.

From 1995-2014 the ICT sector of the 40 economies studied has tripled in terms of value added. In 2014 the US had the largest ICT sector, followed by China, while the EU ranked third with a size of EUR 546.2 billion. The weight of the ICT sector in the total EU economy reached 3.9 %, behind China and India (4.7 %), the United States (5.3 %) and Japan (5.4 %), while in Taiwan it reached 15.9 % in 2014. Within the sector, employment in ICT services grew in all 40 countries, except Russia. However, employment in ICT manufacturing decreased in the majority of countries, except in India, China, Brazil and Taiwan.

## PROMOTING ENERGY EFFICIENCY WITH THE 'CODE OF CONDUCT FOR DATA CENTRES' AWARDS

In June 2017 ENGIE, SKY, and Facebook won the EU code of conduct award for energy efficiency in data centres. The code of conduct is a voluntary and independent initiative for data centres in the EU. Managed by the JRC, it measures energy efficiency in terms of power usage effectiveness (PUE), where the ideal value is 1 PUE. Since the start of the programme in 2008, 354 data centres have asked to join the scheme.

The code of conduct for data centres was created in response to increasing energy consumption in the commercial sector. Energy efficiency measures, including raising awareness of data centre operators and owners, are designed to encourage best practices in the reduction of energy consumption.

Participating companies use a combination of energy saving technologies to increase their power usage effectiveness, including airflow solutions, innovative cooling solutions and rainwater harvesting. Companies also make general commitments to monitor power and energy consumption, adopt management practices, switch off components not needed, and reduce energy consumption where possible.

The winning data centres have been selected from 25 participants who applied for the code of conduct programme between May 2016 and April 2017. SKY won for its data centre 'Ajax 1' in the UK, with a PUE of 1.25. ENGIE Services Zuid in the Netherlands achieved a PUE of 1.28. Facebook's data centre in Sweden managed a PUE of 1.1.

## LEVERAGING THE DIGITAL TRANSFORMATION: STRATEGIES OF LEADING R & D INVESTORS

The digital revolution encompasses a large segment of the socioeconomic sphere. It originally affected those companies which operated in ICT-related sectors, but now most economies and societies are intertwined through digitalisation. A joint JRC-OECD report reflects this, finding that the largest industrial R & D investors drive the development of digital technologies. They own about 75 % of global ICT-related patents, while only 25 % of them operate in the ICT sector.

The publication, launched at the JRC site in Seville during the sixth European Conference on Corporate R & D and Innovation (Concordi 2017), assesses the technologies introduced by major R & D investors in various markets, the digital technologies that pervade different sectors and the strategies that top investors follow to obtain returns from their investments.

The study finds that investing in innovation and knowledge creation brings definite returns, including through intellectual property (IP) rights. Evidence suggests that digital technologies

are a pillar of investors' overall strategy, as nearly half of IP5 patent applications filed in 2012-2014 are ICT related. Companies in the computer and electronics industry are the most reliant on IP rights.

Scientific contributions presented at the Concordi conference show that the EU needs to increase the pace of its industrial modernisation. New technology-based sectors should be fostered in order to address the challenge of creating better jobs and generating the value needed to sustain more inclusive societies. The EU also needs to increase the role of high-tech sectors in the economy.

## HELPING SCHOOLS MAKE THE MOST OF DIGITAL TECHNOLOGIES

In 2017 the European Commission launched the trial version of Selfie, which stands for self-reflection on effective learning by fostering innovation through educational technology. Selfie is based on the European Framework for Digitally Competent Educational Organisations, developed by the JRC and the Directorate General for Education, Youth, Sport and Culture. Schools from 14 countries have been using Selfie in an initial pilot phase, ahead of its 2018 introduction in interested schools in Europe.

The meaningful integration of digital technologies can improve learning and teaching; however, the mere presence of digital technologies does not guarantee better learning outcomes. The practical application of Selfie involves multi-dimensional learning, which includes curricula, teaching practices, school strategies, and student experience. The generated data is anonymous and the answers provide useful material for schools to assess their strengths and weaknesses.

The purpose of Selfie is to create development in all schools, whether digitally advanced or not, in support of EU policy goals to improve digital skills and learning capacity. In recognising that digital-age learning promotes both a top-down and bottom-up approach, Selfie supports the needs of all members of the school community. It can be customised for each school and involves everyone, from leaders and teachers to the students themselves.

## NEW SMART TACHOGRAPH PAVES THE WAY FOR IMPROVED ROAD SAFETY

JRC scientists have prepared the specifications for the new smart tachograph, which monitors and records the driving and resting times of professional drivers. From 2019, all heavy vehicles must be equipped with this improved version of the currently existing digital tachograph. Smart tachographs are connected to the global navigation satellite system (GNSS) and allow for wireless data remote access by control authorities, making the identification of potential offenders easier.

Speeding or sleepy drivers are among the main causes of accidents involving heavy vehicles and semi-trailers. Recording driving and rest times 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.

The JRC led the preparation of certified protection profiles expressing the security requirements on the smart tachograph components. It also provided additional products to support the introduction of smart tachographs, including sample cryptographic material and a cryptographic material generating tool.

## CONTRIBUTING TO STRONG CYBERSECURITY FOR THE EU

Cybersecurity is critical to both our prosperity and our security. As our daily lives and economies become increasingly dependent on digital technologies, we become more and more exposed. In September 2017, the Commission adopted an important new cybersecurity package, which builds upon existing instruments and presents new initiatives to further improve EU cyber resilience and response.

In 2017, JRC work on cybersecurity has informed the preparation of the cybersecurity package, in particular the proposal of an EU framework on the security certification of ICT products and services, and the establishment of the position of the Commission on the challenge of encryption in criminal investigation.

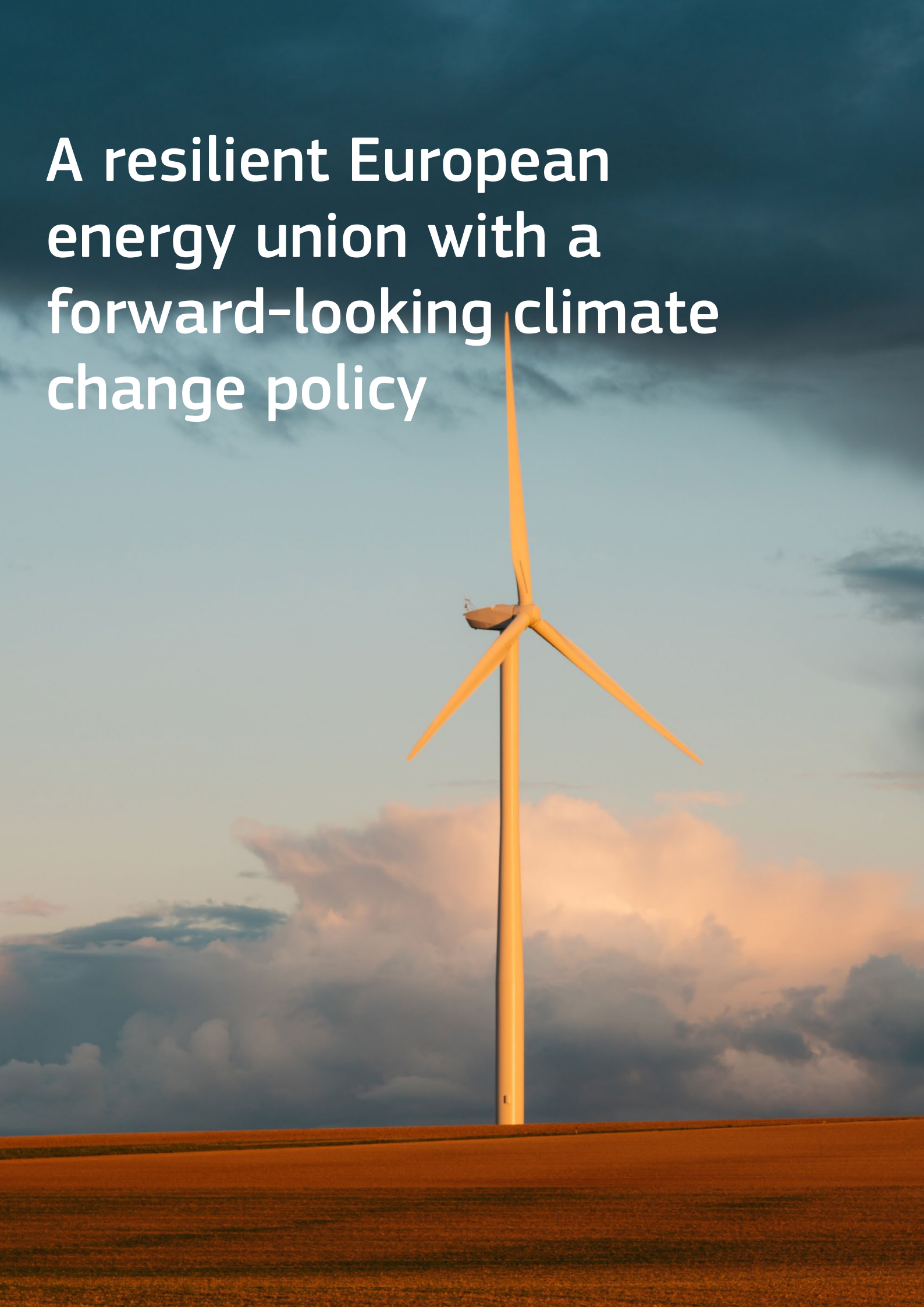
Ongoing work to facilitate implementation of the package includes mapping EU cybersecurity capacity, instrumental for the launch in 2018 of a pilot network of competence centres and the set-up of an EU research and competence centre.

The JRC also actively contributed to the deployment of cybersecurity solutions in several industrial/service sectors: in energy, on cybersecurity requirements for smart grids; in transport, on the security of data communication between vehicles and infrastructures and on the security of the digital tachographs; for eGovernment services, on the use of digital ledger technologies for taxation and customs applications; and in the digital single market, on fostering the exploitation of digital identities.

Support to law-enforcement authorities and Europol is being consolidated with JRC research on digital forensic techniques and smart-home/internet-of-things test-beds for the lawful collection of digital evidence, and on biometric identification techniques and systems for criminal identification.

Significant policy support was underpinned by JRC research on emerging threats to network/software security and on the development of mitigation and protection measures (e.g. ePrivacy revision, zero-day vulnerability), as well as by JRC initiatives on cyber-alertness raising and education (e.g. internet of toys, Happy Onlife edutainment toolkit).

# 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 in slowing down global warming and mitigating its effects while ensuring affordable, secure and sustainable energy for businesses and households.

In 2017, the JRC's contributions to climate change policy focused on mitigation efforts, notably on economic and climate modelling/assessments, monitoring and analysing emissions from different sources (transport, agriculture, etc.), looking into alternative fuels, and assessing climate change impacts (economic and non-economic), vulnerability, resilience, and adaptation options. On energy specifically, the JRC contributed to carrying out security, safety, risk and techno-economic assessments of the EU's energy supply, assessing the development of energy infrastructure and energy markets in the EU, and supporting the implementation of renewable energy and energy efficiency legislation.

## REALISING THE CLIMATE CHANGE MITIGATION POTENTIAL OF FORESTS

Forests have a key role to play in meeting the objectives of the Paris Climate Agreement, in which 187 countries submitted their intended nationally determined contributions (INDCs) to global GHG mitigation actions. In the past, land use, land use change and forestry (LULUCF) has often been treated as a secondary way of reducing net GHG emissions in United Nations Framework Convention on Climate Change negotiations, largely due to complexity and a lack of trust in the data. However, the Paris Climate Agreement of 2015 was a game changer. In 2017, JRC research estimated that when the INDCs are fully implemented in 2030, the LULUCF sector will shift from being a net source of emissions to a net absorber of $CO_2$.

The research also notes that developing countries, in particular, expect the LULUCF sector to contribute to meeting their emissions reduction targets. However, due to varying interpretations, some discrepancies between country reports and scientific assessments lead to confusion which hinders the ability to measure progress towards the 'below 2 °C' target. There is a vital need to reconcile these differences.

JRC scientists therefore call for credible data to track the real mitigation potential of forests, which they estimate could be as high as contributing around 25 % of total INDCs emissions reduction globally through conserving and enhancing forests' $CO_2$ absorption capacity, forests have the potential to contribute about 25 % of total INDCs emissions reduction globally.

## EVIDENCE THAT A CLEAN AND GREEN PLANET IS BOTH POSSIBLE AND AFFORDABLE

In November 2017, JRC scientists attended the 23rd Conference of the Parties to the United Nations Framework Convention on Climate Change, and presented the *2017 Global energy and climate outlook (GECO) report*. According to the GECO report, a cleaner, greener planet is achievable and feasible. Limiting global warming below the critical 2 °C level set out in the Paris Climate Agreement can, in fact, serve economic growth.

The report finds that if the appropriate measures are taken globally to reach the GHG trajectory set out in the Paris Climate Agreement, about 1.5 million lives could be saved annually across the world by 2050. Moving from fossil fuels to sustainable energy could reduce the number of air pollution-related illnesses such as asthma and bronchitis by 15-40 % annually, and increase crop yields by 2.5-6.6 % - thus reducing healthcare costs and the number of people unable to work because of respiratory illness, and potentially increasing agricultural revenue.

The GECO report also confirms that reaching the below 2 °C target would require speeding up the decoupling of emissions from economic growth. From 2020 onwards, decarbonisation efforts must intensify, and from 2015 to 2050 energy intensity should decrease by an average of 5.8 % per year. It is also vital to phase out coal and reduce the use of oil and gas, and to electrify the final energy demand, from 18 % in 2015 to 35 % in 2050.

The JRC and the Netherlands Environmental Assessment Agency also confirmed that carbon dioxide emissions have stalled for the 3rd year in a row. The report is based on the JRC's Emissions Database for Global Atmospheric Research, which is unique in both its space and time coverage, and in its completeness and consistency in tracking the emissions of multiple pollutants: monitoring the main GHGs, air pollutants and aerosols.

## DANGEROUS ARRIVAL OF CLIMATE ANOMALIES IN EUROPE AND ACROSS THE WORLD

The JRC studied the relative importance of heat stress and drought on wheat yields, through developing a new Combined Stress Index in order to better understand the effects of concurrent stress events. They found that heat stress, drought and water excess are the root causes of about 40 % of annual changes in wheat yields.

Flood risks and economic damages under different global warming scenarios with 1.5˚C, 2˚C, and 4˚C increases compared to pre-industrial levels have also been studied. If the average global temperature rises by 4 °C, the flood risk for countries with more than 70 % of the global population will increase by more than 500 %. By the end of this century, weather-related disasters could regularly affect around two-thirds of the European population. The JRC concluded that if no measures are taken, this could result in a 50-fold increase in fatalities.

These findings shed light on the expected burden of climate change on societies across different regions of Europe. Even the most optimistic warming scenario of 1.5 °C would lead to a doubling of the global flood risk. The JRC calls for adaptation plans to be implemented to keep the flood risk rates at or below current levels.

The JRC also analysed the interaction between humidity and heat and found that if global temperatures rise by 4 °C, new super-heatwaves of 55 °C may regularly impact many parts of the world, including Europe. The combination of heatwaves amplified by high humidity could create dangerous scenarios in which the human body is hindered from cooling down through sweating. The study utilises the Apparent Heat Wave Index (AHWI), a composite index for humidity and heat developed by the JRC's Competence Centre on Composite Indicators and Scoreboards.

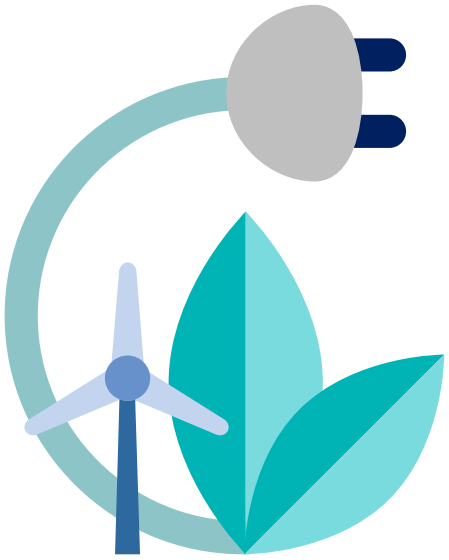
If global temperature increases by up to 2 °C above pre-industrial levels, the combined effect of heat and humidity will likely exceed 40 °C every year in many parts of the world. Europe will have up to a 30 % probability of having such strong annual heatwaves. Rising temperatures and climate change could expose some 350 million Europeans to harmful extremes every year.

## TRACKING PROGRESS TOWARDS COMPLETING THE ENERGY UNION

The JRC provided scientific evidence for several reports forming the basis of the European Commission's second State of the Energy Union package and the third *State of the Energy Union report*. In terms of GHG emissions, energy efficiency and renewable energy, the EU is on track to reach its 2020 targets.

Through the methodologies applied by the JRC with the Strategic Energy Technologies Information System, key performance indicators measured progress in research and innovation in the EU as a whole and for each Member State.

These methodologies are fully transparent, with regards to both data and methodology. This allows stakeholders to review both the methodology used and the outcome, and also triggers feedback to the JRC that can lead to the further improvement of data collection, processing and evaluation mechanisms.



## GROWTH POTENTIAL OF RENEWABLES: OCEAN, WIND, AND SOLAR ENERGY IN EUROPE

Evidence analysed by the JRC shows that the move towards renewable energies is already helping long-term efforts on climate change mitigation. The EU is on track to achieve its 2020 GHG emissions reduction target, thanks in part to changes in its energy mix. JRC analyses finalised in 2017 found that in 2015 the use of renewables in the EU resulted in estimated savings of 751 million tonnes of $CO_2$ equivalent (Mt $CO_2$-eq). Total EU emissions would otherwise have been almost 15 % higher. Emissions from public power and heating systems are estimated to have recorded the largest falls — 40 % in all — from the rollout of renewables in the electricity

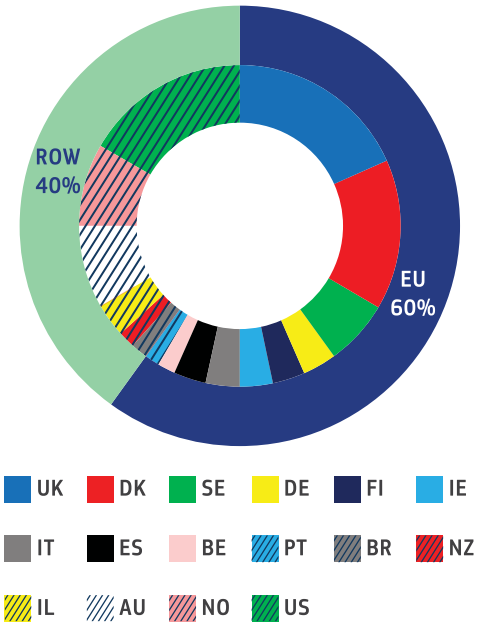
and heating/cooling sectors. Looking further ahead, the trend towards decarbonising the energy system (which averaged 9 % per year from 2009 to 2015) must be maintained and supported. Indeed leadership in renewables is a key EU policy goal. The JRC analyses developments across a range of the most relevant technologies.

The JRC wind energy status report 2016 also presents the EU as a global leader. Wind energy production supplies 140 gigawatts (GW) to the EU's power grid, representing about a third of the world's total generated wind power. In total wind energy production China is ahead of Europe, but not all of it is connected to the electricity grid. The EU is at the forefront of offshore capacity, with about 90 % of the newly finished projects in the world.

The JRC PV status report 2017 highlighted the fact that the compound annual growth rate of solar photovoltaic (PV) manufacturing over the last 15 years was over 40 %, thus making PV one of the fastest growing industries at present. In 2016 138.5 gigawatts of new renewable power capacity was installed and solar power accounted for over 56 % of this capacity. This record installation of new renewable power capacity was made possible by the significant reductions in renewable energy system prices, especially solar PV.

In the area of solar power, the JRC runs the popular Photovoltaic Geographical Information System software for solar capacity analysis, enhanced by the first publicly available European solar power generation dataset. The JRC also developed the European meteorological derived high resolution renewable energy source, which captures geographical information on solar energy fluctuation, providing the interested citizen with an idea of the solar energy that can be harvested in a given location.

Also published in 2017, the *JRC ocean energy status report 2016* describes Europe as the global leader in the development of tidal stream and wave energy technologies. The publication analyses tidal energy, wave energy and ocean thermal energy, which are at different stages of technical and commercial development.




Distribution of wave energy developers in the world
Source: JRC Ocean Energy Database, own analysis

2017 saw the kick-off of the European Strategic Energy Technology Plan temporary working groups (TWGs). These TWGs draft implementation plans that contain concrete R & I activities, and propose relevant funding opportunities for their realisation. The JRC leads the TWGs on batteries and e-mobility and on renewable fuels and bioenergy. The implementation plan associated with the workings of the TWG on renewable fuels and bioenergy is expected to be endorsed by the Steering Group during the first half of 2018.

The JRC's leading role in the development and introduction of international standards for renewable energies, in particular PV solar electricity, resulted in the publication of three new IEC-Cenelec standards in 2017. These were in the area of new material concepts for PV solar electricity dealing with multi-junction PV to anticipate the growing industry trend.

## SUPPORTING STANDARDISATION ON NATURAL GAS QUALITY

In 2017, the JRC provided scientific support to the European Committee for Standardisation (CEN) working group 'Pre-normative study of H-gas quality parameters', which was launched in 2016.

The work relates to the Commission's mandate to CEN for standardisation in the field of gas qualities, which was approved in 2008 and requested the development of a defining standard for gas quality parameters for high-calorific gas (H-gas).

The working group operates under the CEN's Sector Forum Gas — a platform aimed at facilitating the exchange of information between different stakeholders and coordinating and identifying standardisation needs in the field of gas. It is composed of national standardisation bodies, experts from related CEN technical committees and (European) organisations/experts from related sectors such as gas producers (natural gas, biomethane, other renewables, etc.), shippers/traders, operators (grid, storage and liquid natural gas), appliance manufacturers (domestic/industrial) and the European Commission, the Agency for the Cooperation of Energy Regulators (ACER) and the European network of transmission system operators for gas (Entsog).

To support the development of technical scenarios with a robust knowledge base, the group launched a task force to map national and sectoral standards in relation to the Wobbe Index (range, rate of change) and related gas quality parameters in Europe. The task force began by conducting a survey to collect gas quality information from a variety of representative end use points, across several European regions. The results of the survey were presented at a joint CEN/Entsog workshop in September.

The main effort until now has been drafting, publishing and analysing several surveys, as agreed with the experts of the working group, and processing and analysing collected gas

quality data. This work is ongoing and the final report due by May 2019 will contain recommendations and conclusions for the revision of specific quality standards for the Wobbe Index and other identified subjects.


## PROVIDING THE BASIS FOR A COMPETITIVE AND SUSTAINABLE EUROPEAN CAR INDUSTRY

In November 2017, the Commission introduced the second mobility package, seeking to reconcile the ambition of world-leading environmental standards with increasing the competitiveness of our car manufacturing industry to secure jobs and growth. The package is also designed to offer a new deal for consumers, helping to restore citizens' trust and ensure that future mobility is clean and affordable to all. A key pillar of the second mobility package was the Commission proposal for new $CO_2$ targets for cars in 2025 and 2030. Evidence provided by the JRC and using the JRC's DIONE modelling software on new technologies, governance structures and the impact of policy options, formed the basis of the final package and in particular for the $CO_2$ target proposals.

A challenge for the definition of post-2020 $CO_2$ targets was the shift to the newer worldwide harmonised light duty test procedure (WLTP), replacing the aging new European driving cycle (NEDC) based system, which had been criticised for producing large differences between declared $CO_2$ values and real-world emissions. This shift created the lack of an official baseline $CO_2$ level to build the new targets upon. The JRC developed CO2MPAS to correlate $CO_2$ emissions from both test procedures and to derive the missing baseline $CO_2$ level for the new test procedure. Results have shown that the new tests were able to detect an average of 1.21 times more $CO_2$ from standard internal combustion passenger cars (and 1.33 times more for hybrid cars) than the traditional NEDC method.

The results of these JRC studies highlight the need to complement current lab-based certification procedures with additional instruments, such as a fleet-wide fuel consumption monitoring system and advanced tools for customised vehicle information. A first proposal to set up a fleet-wide monitoring scheme to calculate in a correct and systematic way and to keep under control the gap between certified and real-world $CO_2$ emissions was introduced as part of the mobility package (representing a substantial innovation in vehicles' emissions legislation). Concerning vehicle information, the JRC's Green-Driving Tool was indicated in the mobility package as a first step in this direction.

In addition to the new laboratory-based WLTP test procedure, a new vehicle emission certification procedure based on on-road measurements entered into force on September 2017, with the objective of checking real driving emissions (RDE) of new models of light duty vehicles. The JRC contributed, with experimental data and expertise, to the drafting of the RDE legislative packages that will close the gap between pollutant emissions measured in a laboratory environment and real-world emissions. The introduction of the WLTP together with the RDE in the type-approval of light-duty vehicles is strategically important because the same approach has been chosen by the Chinese government. This brings European car manufacturers to the forefront in the car market worldwide.

With ambitious environmental targets, demand for lithium-ion batteries suitable for application in e-mobility and in stationary energy storage is also likely to increase. In 2017, JRC researchers analysed EU competitiveness in advanced lithium-ion batteries for e-mobility and stationary storage applications, identifying the investment required to 'pull down costs along the learning curve' and reach a target battery pack cost that will work both for citizens and industry.

The second mobility package also proposes measures to boost investment in alternative fuel infrastructure. The JRC conducted a thorough analysis of the coherence of Member States' own assessments of the current state and future development of the alternative fuels market in the transport sector, the ambition of national targets and objectives and the measures proposed to reach them.

## SMART GRID PROJECTS OUTLOOK 2017

This rolling review, carried out on a periodical basis by the JRC — in tight cooperation with the Directorate-General for Energy — builds upon the previous two smart grid project inventorying exercises published since 2011. It presents the latest analyses and insights from the most comprehensive database of smart grid projects across the EU.

This study goes hand in hand with brand new interactive visualisation tools allowing the user to generate customisable maps, graphs and charts to track progress on smart grid projects realised in the 28 EU Member States, Switzerland and Norway.

The current edition of the survey includes a total of 950 smart grid projects, launched from 2002 up until today, amounting to EUR 5 billion of investment. Strong differences exist between Member States in the number of projects and the overall level and pace of investment. Private investment is clearly the most important source of financing of smart grid projects, but European and national funding play an important role in leveraging private finance and incentivising investment. Distribution system operators (DSOs) are the stakeholders with the highest investment, but non-traditional actors such as public institutions and other emerging stakeholders are steadily increasing their investment in the field. The domains with highest levels of investment are smart network management, demand-side management and integration of distributed generation and storage, together accounting for around 80 % of the total investment. Many projects however address several domains at the same time to investigate and test the systemic integration of different solutions.

## ELECTRICITY-SUPPLY SECURITY AND RESILIENCE

Electricity security, which has to do with the power system's capability to deliver energy to the users, represents a crucial concern for decision-making at all levels and occupies a prominent place in most of the EU's energy policy action areas.

In particular, the proposal for a regulation on risk-preparedness in the electricity sector has been published within the broader clean energy package. The goal of the proposed regulation is to provide an EU-wide system in case of a major electricity supply crisis, which often is not restricted to one Member State.

Against this background, in 2017 the JRC produced several studies assessing diverse facets of electricity security.

A study on power grid recovery after impact from natural hazard reported on the performance of the power grid during 16 earthquakes, 15 space weather events and 20 floods. The study provided a number of recommendations related to policy, hazard mitigation and emergency management to reduce the risks of natural hazards to electric infrastructure and to improve crisis management in the aftermath of a natural disaster.

Another study characterised electricity security via features at the crossroads of policy and science. It reviewed the electricity security modelling and assessment approaches across sectors, proposed elements for a novel electricity security decision-analytic framework for the EU, and contextualised the proposed framework in EU's Energy Union grid design initiatives.

Ad hoc analyses were also produced to support the definition of the power system risk preparedness regulation proposal. By putting forward EU-wide rules to follow in case of crises, the Commission proposal is intended to bolster regional cooperation and assistance among Member States.

## OPEN ECHO PORTAL SHEDS LIGHT ON UNCONVENTIONAL HYDROCARBON ACTIVITIES IN EUROPE

Unconventional hydrocarbons are sources of oil and gas which require methods for extraction which are not normally necessary in the conventional extraction of hydrocarbons, for example horizontal drilling or hydraulic fracturing.

The Conference 'Transatlantic Knowledge Sharing on Unconventional Hydrocarbons: Resources, Risks, Impact and Research Needs was held on 20-21 June 2017 in Amsterdam (Netherlands). On the occasion, the JRC-led European science and technology network on unconventional hydrocarbon extraction launched the European Unconventional Hydrocarbon Portal (Open ECHO). This is an information portal developed by the European Commission which provides an overview on unconventional hydrocarbon activities in Europe. The portal allows a wide range of users, from citizens to Member States' authorities, energy experts or scientists, to retrieve custom information about hydrocarbons from a single source. The key elements of the portal are three unique and innovative tools.

The European Atlas of Unconventional Hydrocarbons Resources is an interactive information- and data-sharing web map application that renders on maps locations of unconventional hydrocarbon basins, together with resource assessment. The resulting maps can be overlaid on background information about environment risk, socioeconomic information, industrial activity or policy indicators.

The European Database of Unconventional Hydrocarbons Wells, still under development, provides an EU-wide inventory of planned and existing unconventional oil and gas wells. It gathers in one place a wealth of site-specific information on administrative, operational, geological, environmental and risk aspects. It enhances the overall level of transparency and enables close monitoring of the environmental impacts of the unconventional hydrocarbon exploration or production activities.

The Impact Analysis Tool (Energy Market) allows users to browse and display modelling results for economic impacts of unconventional hydrocarbon resources on global energy markets and implications for Europe's future energy markets. The modelling explores quantitatively the potential development of unconventional resources at global scale, and its possible impacts on energy markets, through a scenario analysis.

**Unconventional hydrocarbons present economic and environmental challenges and opportunities that the JRC's Open ECHO platform contributes looking to.**

# 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 R & I 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 2017, the JRC's activities contributing to strengthening the internal market included standardisation, reference measurements and (nano-)materials; support for industrial sectors to enhance their environmental efficiency, energy performance, climate resilience and GHG emissions reductions; material efficiency and the circular economy; advanced manufacturing and key enabling technologies; SMEs and innovative companies; and industrial competitiveness.

## STAIRWAY TO EXCELLENCE: SUPPORTING REGIONAL INNOVATION FOR ALL MEMBER STATES

The stairway to excellence project expanded in 2017 to cover new areas like energy, bio-economy, health, aviation and agri-food and support all regions and stakeholders in all EU Member States. It enables them to access H2020, the EU's research and innovation programme, and make the most of the European Structural and Investment Funds. The project is managed by the JRC and the Directorate-General for Regional and Urban Policy, on behalf of the European Parliament.

Broadening the programme provides regions, industry and organisations with tailor-made support in research and innovation. Academia, business and authorities collaborate to better use resources to foster innovation, economic growth, and social cohesion. It enables dialogue and generates opportunities between key stakeholders with common priorities.

Research carried out by the JRC fosters this collaboration: it includes country-based quantitative reports and qualitative analyses. The stairway to excellence country reports address the issue of bottlenecks affecting the optimal use and combination of key research and innovation funds. Under the Smart Specialisation Platform the JRC has also developed the R & I Regional Viewer to review planned research-related investments.

From its launch in October 2014, the stairway to excellence project covered the 13 Member States that joined the EU during or after 2004, engaging over 1 000 stakeholders in various events. It has now expanded both its geography and its focus, covering new areas like energy, bio-economy, health, aviation and agri-food.

## RESEARCH AND INNOVATION OBSERVATORY MONITORS DEVELOPMENT ACROSS THE EU

The JRC published the 2016 edition of the European Commission's Research and Innovation Observatory reports, assessing the development of research and innovation systems at the level of each EU country and identifying important tasks ahead. According to the 2017 reports, industry collaboration and commercialisation of public research results remain a major challenge for R & I systems in many EU countries, but the demand for human resources is increasingly a central point of R & I policies.

The reports aim to feed into the EU policy process and provide a tool that supports policy learning in the Member States. The 2017 edition has been streamlined to provide the most relevant information on national R & I systems, such as the main policy developments in 2016 (with a special focus on smart specialisation), the economic context and research and development trends, including investment figures.

The report also finds evidence that European R & I systems are focusing more and more on strengthening the innovation

output of SMEs and domestic companies, fostering entrepreneurship and targeting interventions to companies in new knowledge-intensive sectors and young innovative companies with the potential for high growth. At the same time, increases in public and private funding of R & I remain critical for innovators.

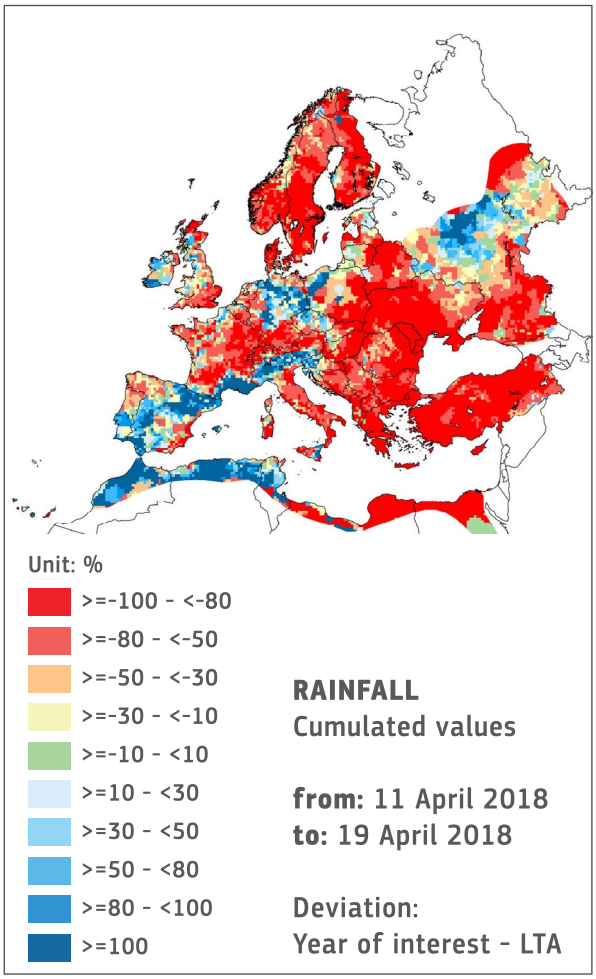
## MARS EXPLORER: THE EU-WIDE CROP AND WEATHER MONITORING E-SERVICE

The JRC has developed a new Monitoring Agriculture with Remote Sensing (MARS) Explorer e-service. The MARS Explorer enables web users worldwide to observe weather and crop conditions across the whole of the EU. Its predecessor, the MARS crop monitoring bulletins, still benefits thousands of individuals and organisations through monthly updates on weather conditions and crop yield forecasts. With the new and advanced e-service, users now have access to a much larger set of data which is updated more frequently.

The new Explorer e-service provides rapid access to high-resolution maps and graphs that are updated three times per month. Weather data is based on observations from several thousand meteorological stations across Europe. Simulations using a computer model give information on crops. Indicators include average, minimum and maximum temperatures, climatic water balance, moisture and rainfall levels.

Users can also follow the progress of a wide range of crops across the EU, including winter wheat, spring barley, grain maize, sunflowers, potatoes, rye, sugar beet and oilseed rape.

The JRC's crop forecasting activities support the EU common agricultural policy by providing scientifically relevant, independent and timely evidence. The e-service was launched to mark the 25th anniversary of the MARS crop monitoring bulletins, celebrated in 2017 in Brussels.




Weather monitoring - Rainfall. © European Union 2018. Source: Joint Research Centre (JRC CGMS 12). Processed by: Alterra consortium

## NEW EU ENVIRONMENTAL STANDARDS FOR LARGE FARMS, COMBUSTION AND CHEMICAL PLANTS

New standards on resources and emissions will help national authorities across the EU to lower the environmental impacts of around 20 000 large poultry and pig farms, around 3 500 large combustion plants and around 3 200 installations that produce large volume organic chemicals (LVOC). The new guidelines come from the review of the Best available techniques (BAT) reference document for the intensive rearing of poultry and pigs, and from similar reference documents regarding large combustion plants and chemical plants.

Each of these stem from JRC-led reviews of old reference documents, with conclusions published in the *Official Journal of the European Union* over the course of 2017. Regarding large combustion plants, the BAT conclusions were voted favourably by Member States with a qualified majority. The JRC led the drafting of the BAT resolutions for large farms through its European Integrated Pollution Prevention and Control Bureau, and in collaboration with the Commission and environmental NGOs.

For the first time at the level, the BAT conclusions set limits on the ammonia pollution to air from animal housing. The conclusions provide a technical basis for national authorities in EU countries to set permit conditions for large poultry or pig farms, which will minimise environmental impacts and support the implementation of several environmental directives. According to the European Environment Agency, agriculture is responsible for 94 % of ammonia emissions and excessive levels of ammonia are linked to negative effects on rivers and lakes, forests and crops.

As well as tightening existing limits for certain pollutants from large combustion plants, the BAT conclusions also set new limits on emissions to air for chemicals like mercury. While the main aim of the LVOC BAT conclusions is to reduce emissions from chemical processes, other environmental issues — like energy efficiency, resource efficiency, wastes and residues — are also covered.

The TRIMIS platform analyses technology trends, research and innovation capacities and developments in the European transport sector.

## THE LATEST RESEARCH ON CLEAN AND INTELLIGENT TRANSPORT

The transport and mobility sector is undergoing a number of technological, economic and social transformations, at an accelerating pace. The Commission aims to turn these challenges into opportunities through the adoption in 2017 of its long-term strategy: 'Europe on the move'. The aim is to pursue clean, safe, connected and automated mobility — developed and produced in Europe — through targeted legislation, infrastructure investment, research and innovation.

As part of these efforts, the JRC helped to create a methodology used in guidance given to help Member States to evaluate if cars have been fitted with defeat devices — the illegal motor vehicle software or hardware which interferes with emissions controls under real-world driving conditions, even if the vehicle passes standard emissions testing. EU countries have the obligation to check the compliance of in-use cars and identify these illegal devices through targeted emission tests.

The gradual development of connected and automated transport is another component of the 'Europe on the move' strategy, along with the objectives related to clean and safe mobility. In 2017, the JRC launched the Transport Research and Innovation Monitoring and Information System (Trimis), a platform which maps and analyses research trends and capacities across Europe's transport sector. Trimis supports transport policymakers and researchers by monitoring the implementation of the Commission's strategic transport research and innovation agenda and by helping to identify innovations with the greatest promise for the future. Thus it aids policymakers to focus on areas where public intervention can create the highest added value.

In addition, the JRC explored the potential impact of connected and automated vehicles (CAVs), as well as intelligent systems that could revolutionise transport as we know it. The study clearly highlights the potentially beneficial impacts of CAVs in terms of reducing road accidents, traffic, pollution and energy use, while also increasing productivity, comfort and accessibility. However, CAV technology still is in its infancy and requires significant oversight to prevent unintended negative consequences such as uncontrolled congestion peaks that could potentially compromise its benefits.

## ADVANCING EUROPE TOWARDS THE CIRCULAR ECONOMY

Addressing the ever increasing demands for resources requires transition towards an advanced circular economy, based on maintaining the value of all materials and resources as long as possible. This transition creates local jobs, growth, and opportunities for social integration while enhancing competitiveness. It also helps the EU to achieve its climate and energy objectives while supporting its commitments on sustainability.

The circular economy is supported by JRC research programmes on energy, raw materials use, eco-fertilisers, and water reuse in agriculture.

In 2017, the European Commission laid out its vision for turning waste into energy as part of the circular economy action plan. This vision is underpinned by JRC research, which finds that although only around 1.5 % of the EU's total final energy consumption was provided by energy recovered from waste in 2014, the efficiency of waste-based energy generation could be increased by more than 25 % using technologies available today. The JRC also contributed to creating standards on material efficiency for energy-related products under the ecodesign directive.

Another example, the JRC report *End of waste work on compost and digestates* is a building block of a new approach to fertiliser production, outlining conditions and technical requirements to transform biodegradable waste into valuable fertilising material.

In November 2017 the JRC launched the Raw Materials Information System, a central knowledge hub that includes the Raw Materials Scoreboard and provides an overview of challenges and opportunities along the entire raw materials value chain. The scoreboard is an initiative of the European Innovation Partnership on Raw Materials and is a benchmark for progress towards a circular economy. It was developed by the JRC in collaboration with DG Internal Market, Industry, Entrepreneurship and SMEs.

## FOOD COLOUR REGULATIONS IN THE EU AND THE UNITED STATES: THE BENEFITS OF CLOSER COOPERATION

Food ingredients tend to be strictly regulated globally. However, as rules often vary between countries and regions, exporters often need to reformulate products for their intended

Despite global cooperation and harmonisation efforts, rules on colorants in food still widely vary from country to country.

marketplace. One example is the significant discrepancy between EU and United States regulation on food colouring. These differences increase costs and can be a barrier to commerce.

Restrictions for use are set for over 600 different food colouring combinations in the EU, while there are few regulatory maximum limits set in the United States. However, the United States does not allow adding colour at all in over 200 foods, while only few food categories are entirely excluded in the EU. However, there is a common trend towards colours from natural sources in the EU and the United States, which is expected to gradually reduce the need for reformulation of products for the export market on both continents.

The JRC teamed up with the University of Stuttgart to compare food colour regulations between these two large trading partners. They assessed existing sets of rules to explore the challenges exporters of processed foods are confronted with. The study confirmed that closer cooperation between regulators would be beneficial for consumers, businesses and regulators alike.

## ASSESSING CONTROL PROFICIENCY IN FIPRONIL DETECTION

In the wake of the 2017 fipronil crisis, many consumers were concerned that the banned insecticide could be present in their food. The JRC organised a proficiency test which confirmed that the overwhelming majority of European control laboratories can accurately detect levels of fipronil in products bound for human consumption. The EU has established a maximum limit of 0.005 mg fipronil for each kilo of eggs.

85 laboratories in Europe participated to the proficiency test. They were sent sets of samples and given 2 weeks to report back on their results. These were compared by the JRC against the independent reference values. It was found that almost all laboratories were able to establish the amount of fipronil and its main degradation product, fipronil sulfone, in the test materials. They correctly determined which of the provided test samples would be non-compliant according to the levels set in EU legislation.

To further support laboratories in assessing the quality of their test results, the JRC is currently preparing a CRM based on fipronil and fipronil sulfone contaminated eggs.

# A deeper and fairer economic and monetary union

Completing the economic and monetary union remains a key objective of the European Commission's current term. 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. Ensuring fair taxation and the good functioning of welfare systems is also crucial. A well-regulated capital markets union encompassing all 28 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 2017, the JRC modelled and carried out socioeconomic analyses to improve macroeconomic, budgetary, structural, and financial development policies in the EU. It also engaged in quantitative analyses for the development of the capital markets union and completion of the banking union. It provided modelling and economic analyses too, in support of fiscal policies, in particular on corporate taxation.

## SUPPORTING THE CAPITAL MARKETS UNION MID-TERM REVIEW

The JRC provided technical support to the mid-term review assessing progress in the capital markets union action plan. A real capital markets union should strengthen the capacity of EU capital markets to provide the necessary funds to firms, foster long-term investment in infrastructures and facilitate cross-border investments.

JRC scientists estimated the degree of EU integration in the equity and bond markets, and found evidence of recovery following the financial crisis. The JRC also identified significant home bias in financial investments, i.e. an overwhelming percentage of national financial products in investment portfolios, but again on a downward trend since 2011. Additionally the lack of diversification for cross-border investments prevents the international capital markets from sufficiently cushioning the negative effects of the sovereign crisis by sharing risks across the EU countries.

Nevertheless, the study does find that the financial integrations of EU capital markets are on a steady recovery. Insight is provided by the JRC Financial and Economic Analysis team, based on estimated econometric models and indices. The analysis builds on a tailor-made database called Finflows that was developed in cooperation with the Directorate-General for Economic and Financial Affairs.

## JRC MODEL DECIPHERS DRIVERS OF GDP GROWTH IN EUROPEAN SEMESTER FORECASTS

In 2017 as in previous years, the JRC deployed its Global Multi-country (GM) model to help understand the drivers of euro-area GDP growth within the official economic forecasts that the Commission publishes in the spring and autumn rounds.

The GM model is a macroeconomic model jointly developed by the JRC and the Directorate-General for Economic and Financial Affairs to perform forecasting, medium-term projections and spillover analysis in sync with the EU's annual cycle of economic surveillance procedures, known as the European semester. It notably allows uncovering the factors driving the behaviour of the observed macroeconomic time series, and so to interpret the forecast data and find out which macroeconomic factors explain the deviation of the GDP growth forecast from its trend.

In the *Spring 2017 forecast*, the GM model showed that demand-side factors dominate in explaining the real forecast GDP growth for 2017. Particularly, it showed that surges in domestic households' and firms' confidence result in higher consumption and investment, respectively. On the other hand, supply-side factors, such as productivity or labour and goods market conditions, have a negative yet smaller impact. Finally, world demand and trade factors have a mild positive contribution to 2017 GDP growth in the euro-area.

In the *Autumn 2017 forecast,* the GM model highlighted that consumption continues to be one of the most decisive positive factors for 2018 forecast real GDP growth, suggesting household attitudes towards consumption and saving are normalising to pre-crisis standards. Additional drivers relevant for 2018 forecast growth relate to labour market and monetary policy. Regarding the former, the main factor consists of an increase of employment due to sluggish real wage growth, whereas the latter is mostly due to the long-lasting effects of pre-2018 policy decisions, which kept low levels of interest rates.

## A COMMUNITY OF PRACTICE BRINGING FINANCIAL SCIENTISTS AND POLICYMAKERS TOGETHER

The JRC launched a community of practice (CoP) in financial research to bring scientists and lawmakers together. 19 European universities and associations attended the opening event with academic experts and policymakers. The aim of the CoP is to strengthen the relationship between scientists and European policymakers and to promote research and collaboration on topics linked to Commission priorities, such as financial stability and capital markets integration.

The CoP provides assurance that research results will reach the relevant policymakers. The work informs the strategy of the Commission to build a capital markets union and to guarantee that financial stability and banking sector resilience are maintained through the banking union.

The opening event centred on current policy priorities and related research opportunities such as the European deposit insurance scheme; OECD work on productivity, insolvency regimes and financial distortions; and the interaction between monetary policy and financial stability.

## IN-DEPTH ANALYSIS OF TAX AND SOCIAL BENEFITS REFORMS FOR THE EUROPEAN SEMESTER

The Directorates-General for Economic and Financial Affairs, for Employment, Social Affairs and Inclusion, and for Taxation and Customs Union asked the JRC to provide tax and social benefits modelling for the 2017 European semester. Its analyses, essentially based on the Euromod microsimulation model, were used extensively and referred to in 15 country reports, which provide the technical underpinning for the country-specific recommendations published in May.

The *ex ante* and *ex post* assessment of reforms was performed in terms of their impact on fiscal revenues, as well as on inequality and poverty. An important innovation in 2017 was the possibility to combine analyses performed with Euromod with those from the QUEST model, building on a joint project of the JRC and the Directorate-General for Economic and Financial Affairs. This allowed to take into account the macroeconomic feedback of reforms and significantly enriched the analysis and policy recommendations that could be derived from it. The impact of reforms on labour supply and employment attracted specific interest, independently of whether such reforms affected work incentives directly (e.g. social security contributions, in-work benefit or personal income taxation) or indirectly (housing taxation or VAT). The analysis

of simultaneous tax reforms (e.g. combined social security and VAT reforms) aimed at reducing the distortionary effect of tax systems (especially for employment) also gained importance. The simulation of such broad policy reforms could be done thanks to the extension of the Euromod model to consumption taxes developed by the JRC over the past 3 years.

## SUPPORTING NEW EU CORPORATE TAX PROPOSALS WITH THE LATEST EVIDENCE



The JRC's scientific input supports the delivery of a growth-friendly and fair corporate tax system. In 2017, the JRC's macroeconomic analysis and impact assessments have helped the Commission to thoroughly reconsider the current taxation of companies in the single market. The evaluations suggest that a fairer and more efficient tax system could be introduced — which may even improve GDP growth and welfare in the EU.

The JRC gave a comprehensive analysis of the common consolidated corporate tax base (CCCTB) proposal for a single set of rules for private companies to calculate their taxable profits, as well as providing an assessment of recently exposed tax avoidance practices. Proposals for policies that would reduce the debt bias in corporate tax rules, such as the introduction of an allowance for growth and investment were also investigated.

Analysing the macroeconomic impact of the proposals required the use of state-of-the-art quantitative modelling techniques. The analysis relied on Cortax, which is an applied equilibrium model covering all EU Member States. The JRC adapted the model to carry out the analysis of the common corporate tax base and CCCTB proposals with the latest data.

## TECHNICAL SUPPORT TO GREECE IN THE CONTEXT OF THE THIRD STABILISATION PROGRAMME

Within the frame of the third memorandum of understanding with Greece, the JRC has been collaborating with the European Commission's Structural Reform Support Service since its inception in 2015 for the assessment of the third Greek stabilisation programme.

In 2017 a JRC researcher was detached for 1 year to the Greek Ministry of Finance in order to provide technical assistance in the context of the discussions it holds with the European Commission, the European Central Bank and the International Monetary Fund. This support has allowed the Greek authorities to access new modelling capacity, particularly the EU-wide microsimulation model Euromod, in order to analyse the fiscal and equity impact of foreseen tax and social benefits reforms. The JRC also provided the Greek Ministry of Finance with training and technical assistance on the management and use of micro-data shared by the Greek tax authority for tax simulation purposes.

# Towards a new policy for migration

Migration is amongst the biggest political, social, and demographic challenges the EU faces. 2015 saw unprecedented numbers of asylum seekers entering the EU, testing the limits of solidarity among Member States. In response to the crisis, the Commission adopted a European agenda on migration, outlining immediate measures and steps to better manage migration in the medium and long term. These include reducing the incentives of irregular migration with a focus on addressing the root causes; border management; strengthening the Common European Asylum System; and developing a new policy on legal migration.

Contributing to this agenda, in 2017, the JRC developed — in the context of the Knowledge Centre on Migration and Demography — unique and innovative instruments to access information and data about migration, notably the Migration Data Catalogue and Dynamic Data Hub, migration profiles for key non-EU countries and maps of migrant communities in EU cities.

## RESEARCH AND KNOWLEDGE MANAGEMENT ON DEMOGRAPHY AND MIGRATION DYNAMICS

In June 2016 the European Commission set up a new Knowledge Centre on Migration and Demography. 1 year on, the centre has made progress and provided EU policymakers with valuable instruments to access information and data about migration. The centre's daily activities are run by the JRC, with its work jointly steered by the main Commission services responsible for migration policies.

At its inception, researchers working for the knowledge centre created an inventory of international and EU-wide data that already existed on migration. They launched the first two data platforms which bring together this wealth of data in one place. The Migration Data Catalogue is an inventory of around 130 existing datasets linked to demography and migration, made available by institutions including the Commission and administrations of some Member States.

The Dynamic Data Hub is a web-based application that builds on the data catalogue and provides interactive direct access to support the European agenda on migration. It covers timely information, including migration flows and socioeconomic data such as population growth, GDP, labour force and world development indicators. It offers a direct entry point to deepen understanding of trends and their impacts on the EU. The hub gathers official statistics and estimates from international organisations, including Eurostat, the UN Refugee Agency and the OECD.

The knowledge centre has created a new generation of migration profiles, providing up-to-date and context-specific information and analysis of key non-EU countries of origin and transit of migrants to Europe. In order to better anticipate future migratory trends, Migration Inclination Indexes will be created and issued by the end of 2018. They will provide reliable information on the root causes, incentives and determinants of migration. The aim is to help quantify the relevance of the different drivers of migration towards Europe and the effects of migration-related policies.

## MENTORING REFUGEE SCIENTISTS

A pilot programme was initiated in 2017 to welcome refugee scientists for a week-long training programme at the JRC. Through this programme, scientists had a chance to be introduced to the European research environment, build up necessary work experience and meet vital contacts to find European jobs in their area of expertise.

The scheme harmonises well with the efforts of the EU, NGOs, academia and European researchers to connect with refugee scientists and share professional experiences. In March 2017, scientists at Ispra welcomed a food technology scientist from Syria, a chemist from Ethiopia and an environmental scientist from Ethiopia, who spent a week at the site to learn more about the JRC's work on consumer product safety and

land resources. Earlier in the month, scientists from Syria and Iraq attended similar training programmes at JRC sites in Geel (Belgium) and Petten (the Netherlands).

The participants left with new ideas and encouragement to continue their scientific careers in Europe. They urged the JRC to continue with the mentoring programmes to reach out towards other refugee scientists and researchers. The JRC is currently looking at how a broader and more permanent programme could be established.

## A UNIQUE MIGRATION DATASET TO SUPPORT INTEGRATION

In October, the JRC unveiled a unique dataset that maps the diverse migrant communities living in the EU, at the level of individual neighbourhoods. The maps provide new insights to support policymakers in developing systems to help migrants integrate in their host countries.

The data allows researchers to calculate the concentration, diversity and segregation of migrants from different countries and compare these indicators within and across cities. Initial findings show a general correlation between how segregated a migrant community is and the geographical and linguistic distance between their countries of origin and destination. For example, Chinese and Filipino communities in Europe are likely to be highly clustered and segregated from their host communities.

The data has the potential to inform a wide range of policy areas, including social services, education, housing and employment. To maximise this potential, the JRC launched a data challenge inviting researchers worldwide to propose research projects connecting the dataset with their area of expertise. An event is planned for the second half of 2018 in Brussels to present the results of the best papers to EU policymakers and local authorities.

The dataset is designed to support the Commission's aim to facilitate evidence-based migrant integration policies, as part of the action plan on the integration of non-EU country nationals and the urban agenda for the EU.

## VOCATIONAL TRAINING AND DATA SECURITY TO HELP MIGRANTS INTEGRATE

At the start of 2017, JRC published a report which found that migrants are still systematically lagging behind their native peers across the EU in terms of acquired skills and

Vocational and work-based training help improve employment rates among migrants

education. While performance varies a lot across groups and EU Member States, the study notes that second-generation migrants and first-generation migrants who arrived before the age of 15 perform better overall than the rest of first-generation migrants, sometimes nearly as well as their native counterparts. This shows the key role that education — including vocational training — can play in a successful integration process.

The study also found that employment rates among low-skilled migrants are higher than among low-skilled natives, which suggests that greater efforts in vocational and work-based training for migrants could help them to make progress in their careers. However, a significant share of migrant human capital remains underused. Migrants with higher levels of skills have lower employment rates than natives.

Integration is also served through data security and authentic, machine-readable travel documents. This includes ID cards, passports or European driving licenses issued by various Member States. In September 2017, the Commission held conformity and interoperability tests for documents with embedded chips, which found failure in only 0.86 % of cases. However, improvements are still possible and the Directorate-General for Migration and Home Affairs, with support from the JRC, continued its work in 2017 on developing inspection system guidelines to ensure the protection of data stored on the chips embedded in these documents.

# 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.

To enhance the EU's and its partners' resilience in this changing global environment, the JRC has undertaken a number of new initiatives to assist Commission services, with the monitoring and implementation of the 2030 agenda for sustainable development and its sustainable development goals and targets (SDGs). The JRC is addressing in particular the areas of food security and nutrition, environment and biodiversity, resource efficiency and sustainable production and consumption, climate, energy, and urban development.

## SCIENCE FOR SUSTAINABLE, AFFORDABLE ENERGY IN SUB-SAHARAN AFRICA

Access to sustainable and affordable energy remains problematic throughout sub-Saharan Africa. In Burkina Faso, only 3.06 % of people in rural areas have access to modern energy sources. A JRC report maps the least costly options for electrification of the country's rural areas, providing a blueprint to transform the energy sector of this country with a population of about 18 million people.

Since 2016, the energy sector in Burkina Faso has been orienting itself towards more sustainable and cost-efficient electricity supply. However, the amount of energy currently produced in the country is far below the demand for its large population, and the country is heavily dependent on imports for its electricity.

The JRC's input utilises a spatial analysis tool to assess potential pathways towards a sustainable rural electrification plan which could be applied in Burkina Faso. It was developed in collaboration with other organisations, including the Energy Ministry of Burkina Faso, and within the framework of the national action plans of the UN's sustainable energy for all initiative. It notably highlights the substantial solar power potential, and encourages the deployment of renewable energy by the government and investors. Findings also indicate that up to 65 % of non-electrified settlements could be served by decentralised technologies.

The JRC supported the expansion of the covenant of mayors initiative to Sub-Saharan Africa and other parts of the world. The JRC also provided data that maps — for the first time — the estimated hydropower potential for the whole of sub-Saharan Africa, with river flow information derived from the Global Streamflow Characteristics Dataset (GSCD) and the Lisflood simulation model for Africa.

## SUPPORTING RESILIENCE, PREVENTION AND MITIGATION OF DISASTERS

In May, the JRC's Disaster Risk Management Knowledge Centre launched its flagship report on science for disaster risk management, a cooperative work of 273 scientists from 26 countries and 172 organisations, with inputs from 11 Commission services. The report presents the state of the art in the field and contributes to the science and technology roadmap of the Sendai Framework for Disaster Risk Reduction.

Early in 2017, the JRC presented the Atlas of the Human Planet 2017 at the UN Global Platform for Disaster Risk Reduction. The atlas is a comprehensive study of human exposure to natural hazards. It covers six major natural hazards: earthquakes, volcanoes, tsunamis, tropical cyclone winds, tropical cyclone storm surges and floods.

The study highlights that global exposure to these hazards doubled between 1975 and 2015, mostly due to urbanisation. Flooding is the most common of the hazards studied in Europe,

JRC-developed flood forecasting methodology is integrated in the Copernicus European Flood Awareness System.

with Germany having the highest number of people exposed to floods. Additionally, over 170 million Europeans are potentially exposed to earthquakes — with over 80 % of people in Italy, Romania, and Greece at risk.

The JRC also analysed areas in which science and knowledge can be further integrated into evidence-based disaster risk management policy. Areas for potential improvement were identified, such as public-private partnerships for risk sharing, which — when addressed — can save more lives and minimise damage from disasters.

The JRC has also developed a number of disaster management and mitigation instruments, including a flood forecasting methodology integrated in the Copernicus European Flood Awareness System, a handbook that supports the EU and non-EU countries to reduce impacts of industrial accidents, a stress test framework for non-nuclear critical infrastructure, such as telecommunication, and a Global Wildfire Information System to monitor wildfires.

## A NEW EARLY WARNING SYSTEM TO MITIGATE DROUGHTS AND FOOD CRISES

In 2017 the JRC developed an early warning system, named 'Anomaly hotspots of agricultural production', which was launched during the European Development Days in June. The system produces monthly reports identifying countries in need of aid interventions or adaptation to their rural development programmes. The system covers 80 countries, and is based mainly on Earth observation through the Copernicus programme, plus meteorological models. It can issue further automatic warnings every 10 days at province level, and make crop monitoring indicators available to technical experts. Through this system, early warning of food production issues in food insecure countries can be provided to the main international coordination mechanisms, such as the Integrated Food Security Phase Classification.

Methodologies developed by the JRC also contributed to the *2017 Global report on food crises*. Compiling this report required the integration of several measurement methodologies and an innovative collaboration between several major international organisations, such as the United States Agency for International Development. According to the report, during 2016 around 108 million people in the world were severely food insecure, a sharp increase on the 80 million observed in 2015. Conflicts are the driving factors in nine of the 10 worst humanitarian crises, underscoring the strong link between peace and food security.

## A NEW INDICATOR OF CONNECTIVITY BETWEEN NATURAL PROTECTED AREAS

The JRC has developed an indicator for the measurement of progress towards meeting the UN connectivity target for ecoregions and protected areas. Connectivity in this case refers to the possibility of animal species, and of the genes and seeds that they carry, to move from one protected area,

such as a Natura 2000 site or national park, to another. This is essential for the conservation of biodiversity and for supporting long-term human well-being.

In 2010, the parties to the UN Convention on Biological Diversity adopted a strategic plan for biodiversity, which includes twenty Aichi biodiversity targets. Under Aichi Target 11, the international community agrees that by 2020 at least 17 % of terrestrial areas will be conserved through well-connected systems of protected areas. Currently, about one third of the world's ecoregions meet the target. The JRC's Protected Connected (ProtConn) indicator quantifies the percentage of land covered by protected and connected areas. It differentiates categories, such as transboundary land through which movement between protected locations may occur. The JRC has assessed the connectivity of protected areas for all terrestrial ecoregions in the world. The detailed results are available from the Digital Observatory for Protected Areas. The indicator will be further developed to cover land at a national level in 2018.

## SCIENCE FOR THE AFRICAN UNION–EUROPEAN UNION PARTNERSHIP

The JRC has cooperated with academic and administrative bodies in Africa for more than 30 years. Its satellite imagery, instruments and research have served the African people across the continent, by forecasting crop yields, carrying out environmental research, providing data when disasters strike, and highlighting demography and migration issues. This wealth of knowledge was described in the JRC flagship report *Science for the AU–EU Partnership*, which was presented at the fifth AU–EU Summit in Abidjan, Côte d'Ivoire, in November 2017.

It is estimated that by 2050, one in four people will live in Africa, whilst temperatures in some parts of Africa may increase by up to 6 °C, despite the fact that its GHG emissions of 4 tonnes per person per year are much lower than the global average of 7.3 tonnes. To cope with these challenges, Africa needs to tap into its natural and human potential, including its considerable hydropower and solar power sources, and its young, increasingly urbanised and increasingly computer literate population.

Urbanisation brings challenges; however, if managed well, it contributes to sustainable growth. The Global Human Settlement Layer, supported by the JRC and the Directorate-General for Regional and Urban Policy, is the most complete, free and open dataset to quantify and understand the issues of human movement. Around half of Africa's population is located within 100 km of the coast, and most do not have access to good quality transport. The JRC's Global Map of Accessibility highlights these remote areas by showing overland travel time to cities that have more than 50 000 inhabitants.

Africa remains the continent most at risk of disasters and humanitarian crises. The combination of conflicts and natural hazards often causes complex and prolonged emergencies. Over the past 40 years, over 400 million people in Africa have been affected by droughts, and 68 million by floods. Undernourishment is still a serious concern, despite the fact

**The Global Human Settlement (GHS) framework produces global spatial information about the human presence on the planet over time.**

that about 20 African states have already achieved the millennium development goal of hunger alleviation.

The scope of the flagship report reflects the evidence collected and the scientific work conducted by the JRC together with its partners in Africa and around the world. The report aims to support and inform an evidence-based dialogue and further engagement with Africa's policymaking and scientific communities, and thus further strengthen, with a solid knowledge base, the renewed AU–EU Partnership.

## PROTECTING OUR CRITICAL INFRASTRUCTURE AGAINST EXTREME SPACE WEATHER EVENTS

Extreme space weather has a global footprint and the potential to damage critical infrastructure on the ground and in space. A JRC study identifies the gaps in reducing risks linked to space weather and makes recommendations for policy, industry and science on how to close these gaps.

Solar radiation storms affect ground- and space-based communications, including the GPS network. They are also a threat to critical infrastructure, including satellites, rail transport and power grid operations. The impact of severe space weather can cross national borders, which means that a crisis in one country can affect the infrastructure in the neighbouring countries. The storms are caused by the emission of magnetised solar plasma, which interacts with the magnetosphere of the earth. However, storm forecasting is hampered by a limited understanding of the release of plasma from the solar corona.

The JRC study calls for a pan-European vulnerability assessment of the power grid to identify critical issues and transboundary effects in case of extreme space weather. Infrastructure operators should also assess whether their systems could be indirectly vulnerable to space weather, for instance due to dependencies on timing and positioning information provided by the GNSS. In addition, better communication between science and industry could provide reliable information to operators for timely decision-making.

The study also advises that the roles and responsibilities of key players in Europe should be better defined and suggests that coordinated strategic investments for improving the scientific know-how in this area could be explored.

## TECHNICAL REACHBACK CAPABILITIES

Reachback capability is understood as the availability of online technical expertise for the interpretation of measured nuclear spectra and assessments of imminent danger, in case of illicit trafficking of nuclear and/or radioactive materials.

In March 2017, together with the global initiative for combating nuclear terrorism (GICNT) and the European reference network for critical infrastructure protection, the JRC organised an international workshop focusing on the need to enhance both national and international technical reachback capabilities and the roles and responsibilities of those providing expert support.

The workshop brought together more than 60 experts from 25 countries, and representatives from the European Commission and the International Atomic Energy Agency (IAEA). Three common reachback challenges were looked

**Solar radiation storms affect ground- and space-based communications, including the GPS network. They are also a threat to critical infrastructure.**


**JRC Karlsruhe hosted Meeting of the Nuclear Forensics International Technical Working Group (ITWG).**

at: information sharing, alarm adjudication and detection technology. The impact of new technology on nuclear security detection architectures was also discussed. A real-time detection demonstration simulating a complex nuclear security event was organised, which focused on core components of alarm adjudication and information exchange between front-line officers, a national reachback centre, and an advanced centralised reachback centre located in Paris.

A list of concrete post-workshop activities was generated to pave the way for further development of European nuclear security capabilities and more broadly for the security of chemical, biological, radiological, nuclear, and explosive materials.

## NUCLEAR FORENSICS: THE CLASH OF CULTURES

In 2017 the JRC hosted three international events on nuclear forensics at its Karlsuhe site.

The 22nd annual meeting of the Nuclear Forensics International Technical Working Group (ITWG) took place in June. More than 100 nuclear forensics practitioners from nuclear measurement laboratories, nuclear regulators and law enforcement services discussed priorities in nuclear forensics research and development, exchanged their latest methodological developments, reported on progress in conducting exercises, on real incidents and in developing guidelines.

A GICNT workshop brought together 35 participants to discuss challenges related to expert witness testimony.

Crime scene management is the responsibility of law-enforcement authorities, but when nuclear or other radioactive materials are present, the potential hazards associated with handling them mean that evidence collection and analysis must be carried out following special protocols. The requirements and ways of thinking of analytical experts differ from those of law-enforcement services, which makes presenting nuclear forensic evidence in court challenging. To help address this issue, an international experts meeting on presenting nuclear forensic evidence in court was organised by the JRC and open to participants of the GICNT event and to ITWG attendees. More than 60 participants highlighted the clash of cultures that arises when scientists and lawyers meet in court.

# LIST OF BOARD MEMBERS AND PARTICIPANTS

(valid as of 31 December 2017)

The Board consists of members and participants. Members are high-level representatives from the EU Member States, and participants are representatives from countries associated with the seventh framework programme or the subsequent framework programme, Horizon 2020.

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

## CHAIRPERSON

**Ms. Annette BORCHSENIUS** — Denmark
Senior Advisor, EU Cooperation on Research and Education, Ministry of Higher Education and Science, Danish Agency for Science and Higher Education

## MEMBERS

**Dr Karel AIM** — Czech Republic
Emeritus Scientist of the Czech Academy of Sciences; Advisor to the Academy Council; Institute of Chemical Process Fundamentals; The Czech Academy of Sciences.

**Dr Hervé BERNARD** — France
Special Advisor to the Chairman, Commissariat à L'Énergie Atomique et aux Énergies Alternatives.

**Prof. Mária BIELIKOVÁ** — Slovakia
Slovak University of Technology in Bratislava; Head of User Experience Research Centre, Institute of Informatics and Software Engineering, Faculty of Informatics and Information Technologies.

**Ms. Susanne BURGER** — Germany
Head of Directorate Europe; Bundesministerium für Bildung und Forschung.

**Dr Claire CRAIG** — United Kingdom
Director of Science Policy, The Royal Society.

**Dr Léon DIEDERICH** — Luxembourg
Premier Conseiller de Gouvernement, Ministère de l'Enseignement supérieur et de la Recherche

**Dr Erik DROP** — The Netherlands
Director of Knowledge Programmes and Government Relations, Netherlands Organisation for applied scientific research.

**Prof. Mark FERGUSON** — Ireland
Director General, Science Foundation Ireland and Chief Scientific Adviser to the Government.

**Prof. Paulo FERRÃO** — Portugal
Presidente do Conselho Diretivo da Fundação para a. Ciência e a Tecnologia.

**Dr Zdenko FRANIĆ** — Croatia
Research Scientist, Institute for Medical Research and Occupational Health; Member of Parliament.

**Ms. Margarida FREIRE** — Belgium
SPP Politique scientifique féderale (Belspo).

**Mr Peter HONETH** — Sweden
Former State Secretary, Ministry of Education and Research.

**Dr Agrita KIOPA** — Latvia
Deputy State Secretary; Director of Higher Education, Science and Innovation, Ministry of Education and Science.

**Prof. Nikolaos MICHALOPOULOS** — Greece
Director, Institute for Environmental Research and Sustainable Development (IERSD), National Observatory of Athens (NOA).

**Dr Toivo RÄIM** — Estonia
Advisor Ministry of Education and Research

**Prof. Pilar SANTISTEBAN** — Spain
Consejo Superior de Investigaciones Científicas; Instituto de Investigaciones Biomédicas Alberto Sols; Centro mixto CSIC y Universidad Autónoma de Madrid.

**Prof. Emmanuel SINAGRA** — Malta
Head of the Chemistry Department, University of Malta.

**Mr Endre SPALLER** — Hungary
Vice-President, National Research, Development and Innovation Office.

**Dr Vassilios TSAKALOS** — Cyprus
Director General Research Promotion Foundation.

**Dr Ioan URSU** — Romania
Scientific Secretary, Horia Hulubei National Institute of Physics and Nuclear Engineering.

**Prof. Antti VASARA** — Finland
President & CEO, VTT Technical Research Centre of Finland.

**Dr. Paolo VENDITTI** — Italy
Senior Counsellor, Consiglio Nazionale delle Ricerche and Societa di Gestione Impianti Nucleari.

**Dr Giedrius VILIŪNAS** — Lithuania
Vice Minister, Ministry of Education and Science.

**Mr Peter VOLASKO** — Slovenia
Ministry of Education, Science and Sport.

**Prof. Albena VUTSOVA** — Bulgaria
Faculty of Economics and Business Administration
Sofia University 'St Kliment Ohridski'.

**Dr Daniel WESELKA** — Austria
Head of Department V/3, Federal Ministry of Science, Research and Economy .

**Waiting for new nomination**: Poland

## PARTICIPANTS

**Dr Kirsten BROCH MATHISEN** — Norway
Director, Division for Energy, Resources and the Environment, The Research Council of Norway.

**Prof. Gheorghe DUCA** — Moldova
President, Academy of Sciences of Moldova.

**Dr Orkun HASEKIOĞLU** — Turkey
Acting Vice President, Scientific and Technological Research Council of Turkey.

**Mr Hallgrímur JÓNASSON** — Iceland
Director General, Rannis.

**Prof. Atanas KOCHOV** — Former Yugoslav Republic of Macedonia
Dean, Faculty of Mechanical Engineering.

**Dr Philipp LANGER** — Switzerland
Head of EU Framework Programmes, Federal Department of Economic Affairs, Education and Research, State Secretariat for Education, Research and Innovation.

**Mr Ammar MIRAŠČIJA** — Bosnia and Herzegovina
Head of Department for Science, Ministry of Civil Affairs.

**Mr Teimuraz MURGULIA** — Georgia
Ministry of Education and Science.

**Prof. Viktor NEDOVIĆ** — Serbia
Assistant Minister for International Cooperation and EU Integration, Ministry of Education, Science and Technological Development.

**Dr Vardan SAHAKYAN** — Armenia
Deputy Chairman, State Committee of Science of the Republic of Armenia.

**Dr Ela STRAUSS** — Israel
Director, Chemistry, Energy, Materials and Nanotechnology, Ministry of Science, Technology and Space.

**Dr Arjan XHELAJ** — Albania
Director General, National Center RASH Academic Network of Albania.

**Prof. Anatoly ZAGORODNY** — Ukraine
Vice-President, National Academy of Sciences of Ukraine.

**Mr Mourad ZGHAL** — Tunisia
Head of Doctoral Schools, Directorate General for Scientific Research, Ministry of Higher Education and Scientific Research.

**Waiting for new nomination:** Montenegro

## SECRETARY OF THE BOARD

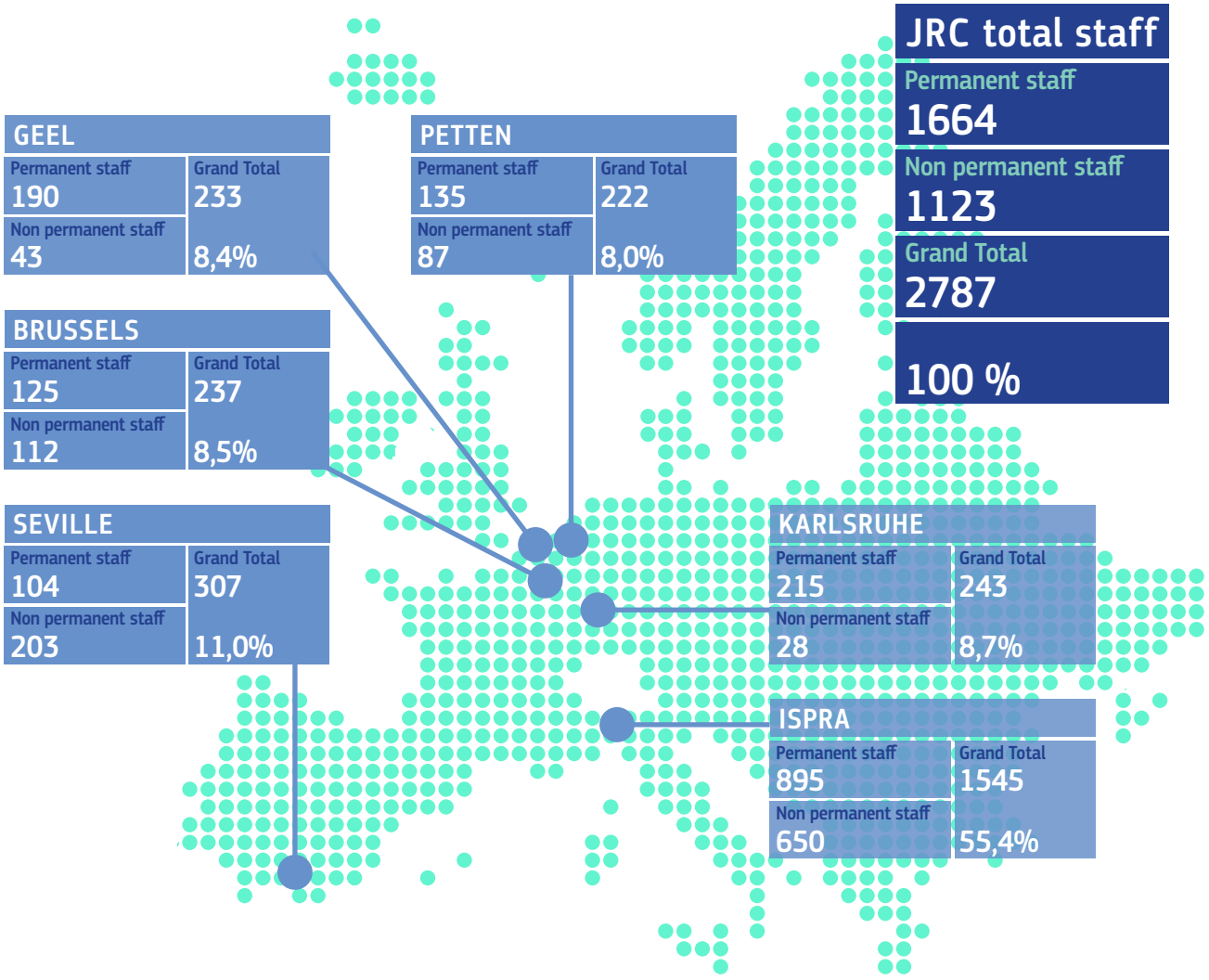
**Ms. Emanuela BELLAN**
Head of Unit, Interinstitutional, International Relations & Outreach, European Commission, Joint Research Centre.

## ASSISTANT

**Ms. Cynthia DENNIS**
Interinstitutional, International Relations & Outreach, European Commission, Joint Research Centre.

# JRC SITES / KEY FACTS & FIGURES

(31 December 2017)




* The JRC's biggest site is Ispra, where 55% of all active staff are located, followed by Seville (11%).
** The four other sites (Brussels, Geel, Karlsruhe and Petten) have a fairly equal number of staff (approx. 8%).

## EQUAL OPPORTUNITIES

By the end of 2017, women represented 38% of the JRC's active staff and 24,4% 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) | 2015 | 2016 | 2017 |
|---|---|---|---|
| Senior management | 27.3% | 38.5% | 50% |
| Middle management | 16.18% | 14.9% | 13.6% |
| Non-management administrators (AD) | 24.27% | 24.1% | 25% |

## 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 2017 budget was spent (in terms of available commitment appropriations, EFTA not included). In addition, € 29,3 million was made available for the programme to decommission the JRC nuclear installations, and for EURATOM-related waste management. An additional € 27,1 million was received in the form of contributions from countries associated to Horizon 2020.

| Outgoing expenditures (in million EUR) | 2016 | 2017 |
|---|---|---|
| Staff expenses | 234.7 | 237.3 |
| Means of execution | 97.2 | 97.2 |
| Operational appropriations (FP) € | 36.4 | 38.0 |
| Total (rounded) | 368.3 | 372.5 |

## JRC CONTRACTUAL INCOME

The value of contracts signed by the JRC in 2017 amounted to € 116,5 million. The table below shows the split of the contracts signed by 31 December 2017. 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) | 2016 | 2017 |
|---|---|---|
| Indirect actions (framework programme) | 7.8 | 10.9 |
| Support to Commission services | 65.8 | 99.7 |
| Third party work | 15.2 | 5.9 |
| Total (rounded) | 88.8 | 116.5 |

## STAFF

The total number of active staff working at the JRC on 31 December 2017 was 2787. Of the total, about 70 % of staff was work programme staff and 30 % support services staff. Work programme staff includes core research staff and technical support staff. Support services staff includes support entities and administrative support staff in scientific directorates.

European Commission

# JRC – JOINT RESEARCH CENTRE
# ORGANISATIONAL CHART – 1 APRIL 2018

## STRATEGY & COORDINATION

**DIRECTOR-GENERAL**
**VLADIMÍR ŠUCHA**
BRUSSELS

**DEPUTY DIRECTOR-GENERAL**
**MAIVE RUTE**
BRUSSELS

**PRINCIPAL ADVISER FOR GENERATION IV**
**THOMAS FANGHÄNEL**
BRUSSELS

**ASSISTANT TO THE DEPUTY DIRECTOR-GENERAL**
.....
BRUSSELS

**ADVISER FOR POLICY COMMUNICATION**
**GERALDINE BARRY**
BRUSSELS

**ADVISER FOR POLICY SUPPORT**
**PIERRE NICOLAS**
BRUSSELS

**ADVISER FOR EVALUATION & SCIENTIFIC INTEGRITY**
**PIETER VAN NES**
BRUSSELS

**ADVISER FOR SCIENTIFIC DEVELOPMENT**
**MARION DEWAR**
BRUSSELS

**ASSISTANT TO THE DIRECTOR-GENERAL**
**MARGARITA NIKOLOVA**
BRUSSELS

**ASSISTANT TO THE DIRECTOR-GENERAL**
**JEAN-BAPTISTE HERBOUT**
BRUSSELS

## KNOWLEDGE PRODUCTION

**B- GROWTH & INNOVATION**
**LUIS DELGADO SANCHO (ACTING)**
SEVILLE

**B.1- FINANCE & ECONOMY**
**FRANCESCA CAMPOLONGO**
ISPRA

**B.2- FISCAL POLICY ANALYSIS**
**DANIEL DACO**
SEVILLE

**B.3- TERRITORIAL DEVELOPMENT**
**ALESSANDRO RAINOLDI**
SEVILLE – ISPRA

**B.4- HUMAN CAPITAL & EMPLOYMENT**
**IOANNIS MAGHIROS**
SEVILLE – ISPRA

**B.5- CIRCULAR ECONOMY & INDUSTRIAL LEADERSHIP**
**LUIS DELGADO SANCHO**
SEVILLE

**B.6- DIGITAL ECONOMY**
**ALESSANDRO ANNONI**
SEVILLE – ISPRA

**C- ENERGY, TRANSPORT & CLIMATE**
**PIOTR SZYMANSKI**
PETTEN

**ADVISER SITE COORDINATION AND EXTERNAL RELATIONS**
**JOSEPHINA PIJLS**
PETTEN

**C.1- ENERGY STORAGE**
**PIETRO MORETTO ACTING**
PETTEN

**C.2- ENERGY EFFICIENCY & RENEWABLES**
**CHRISTIAN THIEL**
ISPRA

**C.3- ENERGY SECURITY, DISTRIBUTION & MARKETS**
**MARCELO MASERA**
PETTEN – ISPRA

**C.4- SUSTAINABLE TRANSPORT**
**ALOIS KRASENBRINK**
ISPRA

**C.5- AIR & CLIMATE**
**ELISABETTA VIGNATI**
ISPRA

**C.6- ECONOMICS OF CLIMATE CHANGE, ENERGY & TRANSPORT**
**ANTONIO SORIA RAMIREZ**
SEVILLE

## KNOWLEDGE MANAGEMENT

**H- KNOWLEDGE MANAGEMENT**
**KRZYSZTOF MARUSZEWSKI**
ISPRA

**H.1- KNOWLEDGE FOR GEOGRAPHIC COORDINATION**
**DAVID MAIR**
BRUSSELS

**H.2- KNOWLEDGE FOR THEMATIC COORDINATION**
**MARC WILIKENS**
ISPRA – BRUSSELS

**B.7- KNOWLEDGE FOR FINANCE, INNOVATION & GROWTH**
**XABIER GOENAGA BELDARRAIN**
BRUSSELS – SEVILLE

**C.7- KNOWLEDGE FOR ENERGY UNION**
**EFSTATHIOS PETEVES**
PETEN – BRUSSELS

**I- COMPETENCES**
**XAVIER TROUSSARD (ACTING)**
ISPRA

**I.1- MODELLING, INDICATORS & IMPACT EVALUATION**
**SVEN LANGEDIJK**
ISPRA

**I.2- FORESIGHT, BEHAVIOURAL INSIGHT & DESIGN FOR POLICY**
**XAVIER TROUSSARD**
BRUSSELS

**I.3- TEXT & DATA MINING**
**CHARLES MACMILLAN (ACTING)**
ISPRA – BRUSSELS

**I.4- INTELLECTUAL PROPERTY & TECHNOLOGY TRANSFER ***
**GIANCARLO CARATTI DI LANZACCO**
BRUSSELS

## SUPPORT

**R- RESOURCES**
**MAIVE RUTE (ACTING)**
BRUSSELS

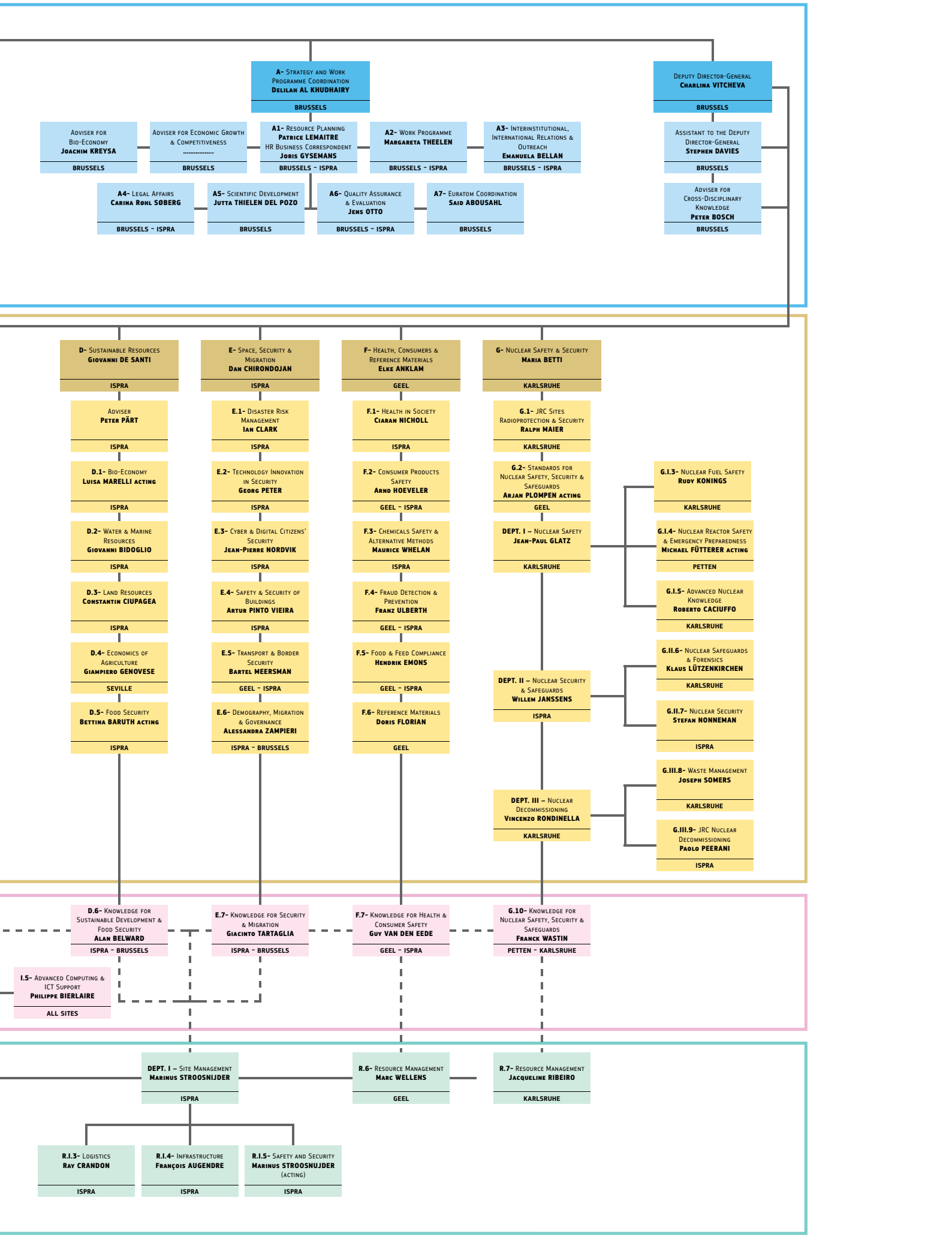
**ADVISER FOR PUBLIC TENDERING & COMPLIANCE**
**ERIC FISCHER**
BRUSSELS

**R.1- RESOURCE MANAGEMENT**
**VINCENZO CARDARELLI**
SEVILLE

**R.2- RESOURCE MANAGEMENT**
**FRANCESCO SCAFFIDI-ARGENTINA**
PETTEN

**R.8- FINANCE & PROCUREMENT**
**IAIN FORMOSA**
ISPRA – BRUSSELS

**R.9- BUDGET & ACCOUNTING**
**STANISLAV DRAPAL**
ISPRA – BRUSSELS


A- Strategy and Work Programme Coordination
Delilah AL KHUDHAIRY
BRUSSELS
Deputy Director-General
Charlina VITCHEVA
BRUSSELS
Adviser for Bio-Economy
Joachim KREYSA
BRUSSELS
Adviser for Economic Growth & Competitiveness
.....
BRUSSELS
A1- Resource Planning
Patrice LEMAITRE
HR Business Correspondent
Joris GYSEMANS
BRUSSELS - ISPRA
A2- Work Programme
Margareta THEELEN
BRUSSELS - ISPRA
A3- Interinstitutional, International Relations & Outreach
Emanuela BELLAN
BRUSSELS - ISPRA
Assistant to the Deputy Director-General
Stephen DAVIES
BRUSSELS
A4- Legal Affairs
Carina Rohl SØBERG
BRUSSELS - ISPRA
A5- Scientific Development
Jutta THIELEN DEL POZO
BRUSSELS
A6- Quality Assurance & Evaluation
Jens OTTO
BRUSSELS - ISPRA
A7- Euratom Coordination
Said ABOUSAHL
BRUSSELS
Adviser for Cross-Disciplinary Knowledge
Peter BOSCH
BRUSSELS
D- Sustainable Resources
Giovanni DE SANTI
ISPRA
E- Space, Security & Migration
Dan CHIRONDOJAN
ISPRA
F- Health, Consumers & Reference Materials
Elke ANKLAM
GEEL
G- Nuclear Safety & Security
Maria BETTI
KARLSRUHE
Adviser
Peter PÄRT
ISPRA
E.1- Disaster Risk Management
Ian CLARK
ISPRA
F.1- Health in Society
Ciaran NICHOLL
ISPRA
G.1- JRC Sites Radioprotection & Security
Ralph MAIER
KARLSRUHE
D.1- Bio-Economy
Luisa MARELLI acting
ISPRA
E.2- Technology Innovation in Security
Georg PETER
ISPRA
F.2- Consumer Products Safety
Arnd HOEVELER
GEEL - ISPRA
G.2- Standards for Nuclear Safety, Security & Safeguards
Arjan PLOMPEN acting
GEEL
G.I.3- Nuclear Fuel Safety
Rudy KONINGS
KARLSRUHE
D.2- Water & Marine Resources
Giovanni BIDOGLIO
ISPRA
E.3- Cyber & Digital Citizens' Security
Jean-Pierre NORDVIK
ISPRA
F.3- Chemicals Safety & Alternative Methods
Maurice WHELAN
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DEPT. I – Nuclear Safety
Jean-Paul GLATZ
KARLSRUHE
G.I.4- Nuclear Reactor Safety & Emergency Preparedness
Michael FÜTTERER acting
PETTEN
D.3- Land Resources
Constantin CIUPAGEA
ISPRA
E.4- Safety & Security of Buildings
Artur PINTO VIEIRA
ISPRA
F.4- Fraud Detection & Prevention
Franz ULBERTH
GEEL - ISPRA
G.I.5- Advanced Nuclear Knowledge
Roberto CACIUFFO
KARLSRUHE
D.4- Economics of Agriculture
Giampiero GENOVESE
SEVILLE
E.5- Transport & Border Security
Bartel MEERSMAN
GEEL - ISPRA
F.5- Food & Feed Compliance
Hendrik EMONS
GEEL - ISPRA
G.II.6- Nuclear Safeguards & Forensics
Klaus LÜTZENKIRCHEN
KARLSRUHE
DEPT. II – Nuclear Security & Safeguards
Willem JANSSENS
ISPRA
D.5- Food Security
Bettina BARUTH acting
ISPRA
E.6- Demography, Migration & Governance
Alessandra ZAMPIERI
ISPRA - BRUSSELS
F.6- Reference Materials
Doris FLORIAN
GEEL
G.II.7- Nuclear Security
Stefan NONNEMAN
ISPRA
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