



AGENCE NATIONALE DE LA RECHERCHE

ANR

Work Programme 2015

& Generic call for proposals 2015

Publication date of the generic call for proposals:
10 July 2014

Submission deadline for pre-proposals
(PRC, PRCE, JCJC instruments):
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Pre-registration deadline
(PRCI instrument):
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A. Context and objectives of the Work Programme 2015

A-1) CONTEXT

The French National Research Agency (ANR) finances and promotes basic and applied research, technology transfer and public-private partnerships, with the goal of promoting excellence at both the academic and technological levels by means of a rigorous selection process based on evaluation by peer review. The ANR's mission also includes strengthening scientific cooperation at a European and international level, by elaborating programmes that are consistent with European and international initiatives. Therefore, the French National Research Agency supports international consortiums in partnership with other funding agencies in Europe and around the world.

The Work Programme 2015 (WP 2015) constitutes the ANR's roadmap for 2015. It falls within the scope of the Strategic Agenda for Research, Transfer and Innovation "France Europe 2020¹", which is consistent with the structure of the European Framework Programme Horizon 2020.

In accordance with this Strategic Agenda, the French "National Research Strategy" (SNR²) which was promulgated by the higher-education and research law titled "*Loi sur l'enseignement supérieur et la recherche du 22 juillet 2013*" aims to deal with the scientific, technological, environmental and societal challenges, by promoting a high-level basic research.

The ANR's 2015 Work Programme is structured in a manner fully in accordance with the National Research Strategy (SNR). Its section devoted to challenges sets forth the priorities defined by the workshops that were held for purposes of implementing the Strategy³. The Work Programme also incorporates the contributions of the five national thematic Alliances⁴, the CNRS and the relevant ministries⁵. The Work Programme is a single consolidated document that was adopted on 26 June 2014 by the ANR governing board.

The Work Programme 2015 describes the main actions and calls for proposals issued by the French National Research Agency for financial year 2015, providing then a general visibility on the ANR's offer for research funding. The Work Programme is addressed to all scientific communities and all public or private players involved in French research, and in particular small and medium-sized enterprises (SMEs) and very small enterprises (VSEs).

¹ http://cache.media.enseignementsup-recherche.gouv.fr/file/FranceEurope_2020/21/7/AgendaStrategique_252217.pdf

² <http://www.enseignementsup-recherche.gouv.fr/cid78720/la-strategie-nationale-de-la-recherche-definit-les-grandes-priorites-de-la-recherche-francaise.html>

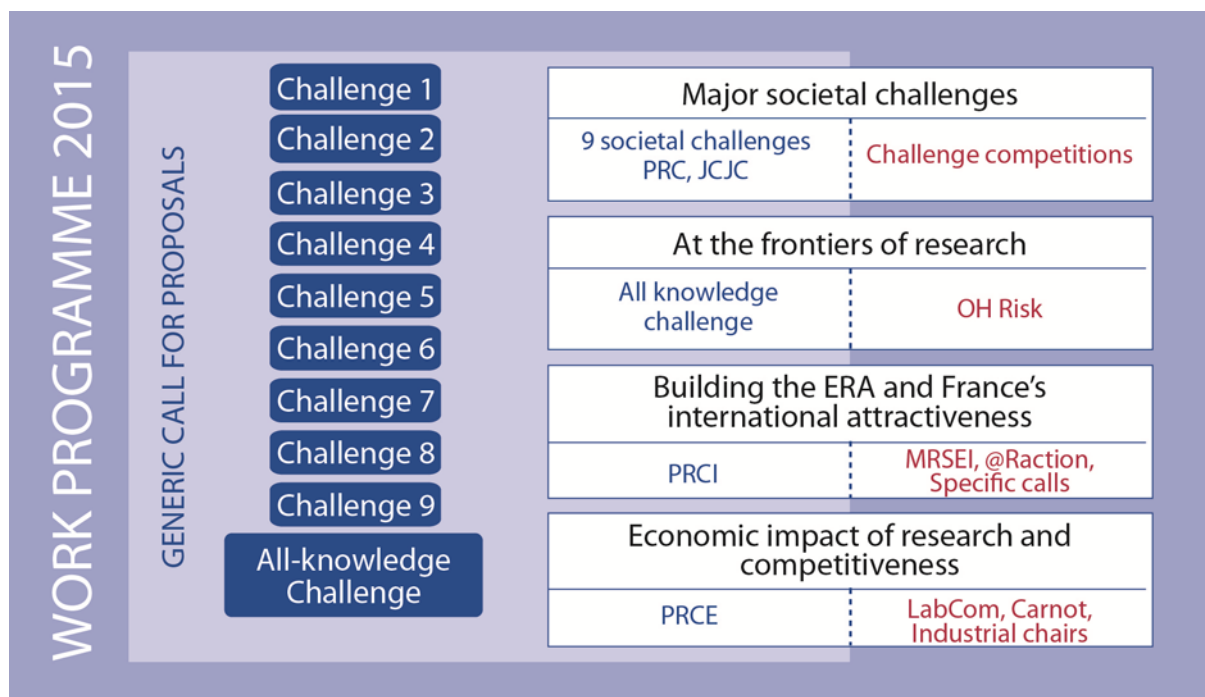
³ <http://www.enseignementsup-recherche.gouv.fr/cid78802/strategie-nationale-de-recherche-bilan-des-travaux-des-10-ateliers.html>

⁴ Allenvi (Alliance for environmental research), Allistene (Digital science and technology alliance), Ancre (National alliance for the energy research coordination), Athena (National alliance for social sciences and the humanities), Aviesan (National alliance for life sciences and healthcare sciences)

⁵ Ministries in charge of: research and higher education; agriculture; ecology; healthcare; industry, defense; foreign affairs; culture; national education

A-2) STRUCTURE AND OBJECTIVES OF THE WORK PROGRAMME 2015

The Work Programme 2015 (WP 2015) is divided into **four interlocking components** each of which has its own budget. Each component also has its own programmes, funding instruments, and calls for proposals, which are shown in the graphic below. A large part of the Work Programme is subject to a **generic call for proposals**, which is also described in this document.



Overview of the Work Programme 2015 and its four components

(French acronyms for funding instruments:

PRC: collaborative research projects; JCJC: young researchers;

PRCI: international collaborative research projects; PRCE: collaborative research projects involving enterprises;

MRSEI: Setting up European or international scientific networks)

The **funding instruments** available from the ANR are detailed in this document ([See §B](#) and [§E](#)). Each such instrument has its own raison d'être, specific expected impacts, and distinct characteristics in terms of selection and follow-up/monitoring. The purpose of these funding instruments may be to support collaborative research, research by individuals, or any of the other programmes and calls for proposals described in section E of this document. Applicants will need to indicate the funding instrument that will best serve the needs and scientific objectives of their particular project.

The **four components** of the Work Programme 2015, which integrate a range of strategic dimensions, will now be described.

1. “Major societal challenges” component

The Ministry for National Education, Higher Education and Research (MENESR) asked the French National Research Agency to organise a large part of its Work Programme 2015 around **nine major societal challenges** identified in the “France-Europe 2020” Strategic Agenda, which is itself consistent with the structure of the European Horizon 2020 framework programme:

1. Efficient resource management and adaptation to climate change
2. Clean, secure and efficient energy
3. Industrial renewal
4. Life, health and well-being
5. Food security and demographic challenges
6. Sustainable mobility and urban systems
7. Information and communication society
8. Innovative, inclusive and adaptive societies
9. Freedom and security of Europe, its citizens and its residents

For a detailed description of these challenges, see sections [§D-1 through D-9](#). The Major societal challenges component that pertains to basic cognitive research, as well as targeted and often finalised research, is subject to a **single generic call for proposals**, whose topics and scientific disciplines are consistent with the National Research Strategy. This component uses various types of instruments (see section [B](#) for details) that allow for the funding of (a) collaborative research projects in a national or international context (**PRC** and **PRCI** respectively) and possibly involving enterprises (**PRCE**); or (b) individual research projects carried out by young researchers (**JCJC**).

Apart from the afore mentioned challenges, the Major societal challenges component calls for the use of an instrument called “**Challenge Competitions**”, whereby various teams of researchers compete against each other on highly targeted topics ([see section §E-1](#)). Each such Challenge Competition is subject to a specific call for proposals.

2. “At the frontiers of research” component

This component allows an additional challenge, known as the **All-Knowledge challenge** (DefSav, see section [D-10](#)), to be incorporated into the generic call for proposals. The goal of this challenge is to give all scientific communities the opportunity to finance projects that do not fall within the scope of the nine societal challenges described above. This challenge, which provides support for basic cognitive research, aims to foster prospective or exploratory research that can potentially expand the frontiers of knowledge beyond that related to the major societal challenges. The funding instruments available for this challenge are identical to those for the Major Societal Challenges component (see section [B](#)).

Apart from the All-Knowledge challenge, the “At the Frontiers of Research” component incorporates an additional instrument known as the “**OH Risk**” programme, which aims to foster the emergence of high-risk scientific projects. This programme is subject to a specific call for proposals ([See E.2](#)).

3. “Building the European Research Area (ERA) and France's international attractiveness” component

This component aims to provide French researchers and teams with funding instruments that allow for the influence and appeal of French research to be expanded, and that promote the building of the European Research Area (ERA). These actions complement those carried out under the Horizon 2020 programme. They aim to foster the development of high-level international research partnerships and to make French teams leaders in the context of European and international programmes.

The Work Programme 2015 challenges have a strong European and international dimension. First, they have been designed, on a sector by sector basis, to be consistent with and complementary to the Horizon 2020 societal challenges. Then, some of the challenges were defined in consistence with European programmes (e.g. ERA-NETs, JPIs, ERA-NETs COFUND, etc.) and international programmes (e.g. Belmont Forum, etc.). Finally, bilateral agreements, within the context of the challenges, between the ANR and foreign agencies, allow for the establishment of strategic partnerships or facilitate international collaboration in a research area without frontiers (see section E).

The “*Building the ERA and France’s international attractiveness*” component comprises the following funding instruments in the Work Programme 2015:

- “Setting up European or international scientific networks” (**MRSEI**) aims to strengthen the position and influence of French research in the European and international spheres. This instrument is subject to a specific call for proposals ([see §E-7](#))
- “Hosting high-level researchers” (**@RACTION**) allows top scientific researchers to be hosted in France. This instrument is subject to a specific call for proposals ([see §E-8](#))
- The “international collaborative research projects” (**PRCI**) instrument aims to facilitate collaborative research with a second country, within the framework of bilateral agreements (for a description of this instrument, see [§B-1](#); and §F - [table 1](#) for an overview of the bilateral agreements. This instrument falls within the scope of the generic call for proposals.
- In addition to these instruments, the French National Research Agency develops dedicated bilateral and multilateral calls within the framework of joint programming initiatives (JPIs), European instruments in the context of FP7 (ERA-NETs for instance) and Horizon 2020 (e.g. ERA-NETs COFUND) – as well as within the framework of other multinational actions pertaining to global challenges (e.g. G8-HORCs, the Belmont Forum) (see section F-[table 2](#) for a summary of these specific calls for proposals).

4. “Economic impact of research and competitiveness” component

This component aims to facilitate partnerships with business community and promote the transfer of public research’s results to industrial applications.

To this end, the French National Research Agency supports projects carried out under partnership with enterprises and that have a direct impact on the economy and competitiveness, via the “**collaborative research projects involving enterprises**” (PRCE) instrument, which falls within the scope of the generic call for proposals ([see §B-1](#)). In addition to this instrument, this component is also based on the following specific programmes:

- **LabCom**
For the purpose of establishing research facilities in which public research institutions and SMEs or intermediate-sized enterprises (ETI in French) should be associated ([see §E-3](#))
- **Industrial chairs:**
For the purpose of establishing chairs at public research facilities, in partnership with enterprises, and financed jointly by the latter and the ANR ([see §E-4](#))
- **Carnot Institutes:**
For the purpose of promoting the development of contractual research involving public-private partnerships ([see §E-5](#))

Moreover, this component enables the French National Research Agency to work with competitiveness clusters with the aim of making research outcomes more compatible with the socio-economic world. Hence, as in the past, ANR calls for proposals can be supported by such clusters.

A-3) OTHER SOURCES OF FUNDING

In line with its funding for project-based research activities, the French National Research Agency has partnerships with other funding bodies such as the ministry in charge of defence (the French Defence Procurement Agency, DGA), the ministry in charge of health (General Directorate for Care Provision, DGOS), the National Solidarity Fund for Autonomy (CNSA), and the Research Foundation for Aeronautics and Space (FRAE). These partnerships provide research funding opportunities that complete the ANR's operating budget for either the generic call for proposals or for specific calls for proposals. Examples of such opportunities include the **Astrid** and **Astrid Maturation** programmes, which are implemented by the ANR and are financed by the DGA ([see §E-6](#)).

In addition, other public institutions also provide funding for project-based research and issue their own calls for proposals, e.g. the National Cancer Institute (Inca) and the National Agency for Research on HIV and Hepatitis A (ANRS). In the interest of efficiency, such proposals and the related projects are not supported by the French National Research Agency. Applicants for such projects wishing to submit a proposal to the ANR concerning areas that are traditionally supported by such institutions should base their arguments⁶ on the reasons why it makes more sense to submit their proposal to the ANR than to one of these other organisations.

⁶ Argumentation to be incorporated into their pre-proposal's scientific document, and if applicable in the full proposal

B. Funding instruments for the generic call for proposals

The 2015 generic call for proposals mobilizes a number of funding instruments. Researchers will need to choose which of these instruments will best serve the needs and scientific objectives of their project.

The funding instruments come under two categories, the rationale and characteristics of which are of key importance in the selection and follow-up of the relevant projects:

- The “*collaborative research*” category pertains to research work defined on the basis of a description of the objectives to be attained within a framework of predefined resources and deadlines. The following three instruments are available in this regard: **collaborative research projects (PRC)**, **“collaborative research projects involving enterprises” (PRCE)**, and **“international collaborative research projects” (PRCI)**.
- The “*researcher*” category relates to support for work carried out by individuals within a research body, the goal being for them to gain, maintain or increase high-level scientific visibility and expand the scientific influence of their home research institutions. The following instrument comes into play here: “Young researchers” (JCJC).

Note: Project grants for all funding instruments (PRC, PRCE, PRCI and JCJC) generally range from €100,000 to €800,000, for a 24 to 48 month period, depending on the type of consortium and the number of partners involved, and the scientific goals of the project in question.

B-1) DEDICATED FUNDING INSTRUMENTS FOR COLLABORATIVE RESEARCH

B-1-1) Collaborative research projects (PRC)

This is the main ANR funding instrument. Collaborative projects aim to achieve results by pooling the skills and resources of various academic or public sector research teams. By facilitating collaboration, the grants expedite the proposed research. This instrument encourages academic or public sector research teams to work on projects for which collaboration provides added scientific value, either because it makes the work possible, or because it paves the way for more ambitious or higher quality results. Proposals for multidisciplinary research work are welcome in this instrument category.

The reviewers involved in the project selection process will evaluate the collaborative nature of proposals that are submitted under this funding instrument. The collaborative nature of a given project will be evaluated not merely based on the number of partners involved, but also in light of the value that the proposed partnership will create, and the opportunities that obtaining the grant in question will open up for the project, in a context of scientific originality compared to the scientific work usually being carried out by the teams or entities involved. A project entailing an extremely high scientific level may, in exceptional cases, be allowed to apply for a grant even if the project is being proposed by only one team.

B-1-2) Collaborative research projects involving enterprises (PRCE)

Collaborative projects conducted as partnerships between public research laboratories and private companies aim to jointly achieve research results that will be advantageous to both parties, by enabling public research facilities to address new research issues, or to address them in a different way, and by enabling companies to access high-level public research in order to improve their innovation capacities.

The reviewers involved in the project evaluation process will evaluate the relevance and solidity of this type of collaboration in proposals submitted under this funding instrument. The type of collaboration will not be evaluated merely on the basis of the involvement of research organisations and enterprises per se in the project, but rather based on the shared objectives in terms of competencies, opportunities, and interests concerning the outcomes of the research.

B-1-3) International collaborative research projects (PRCI)

The ANR partners with foreign funding agencies with the goal of facilitating collaboration between research teams in various countries. The ANR enters into bilateral agreements on targeted topic areas; or such agreements may encompass all of the research areas funded by the ANR.

In such cases, each agency funds its own country's teams.

The International collaborative research projects (PRCI) instrument is mainly dedicated to bilateral collaborations. Robust synergy is expected among the partners of the projects. It implies equal involvement of the French and foreign partners; and the identification of actual scientific coordinators for the projects in each country. These projects can be conducted either by public research organisations, or via collaboration between such organisations and one or more enterprises.

For the Work Programme 2015⁷, the bilateral agreements concluded by ANR concern the following countries (see [table 1 §F-2](#)):

- In Europe: Germany, Austria and Switzerland
- Internationally: Canada, Brazil, Turkey, India, China, Singapore, Taiwan, Hong Kong

Annexes specific to each country set forth the eligible topic areas and the specific submission and selection procedures that apply in addition to those defined for the generic call for proposals that are described in the guide for applicants. These country specific annexes can be downloaded on the page dedicated to the generic call on ANR website (<http://www.agence-nationale-recherche.fr/en>).

The reviewers involved in the project evaluation process will evaluate the international nature of proposals submitted under this funding instrument. The evaluation of the international nature of a given project will be based not merely on the involvement of partners from two countries in the project, but also on the degree to which the scientific and financial contributions of each partner from each country are reciprocally well balanced, as well as on the shared opportunities and interests that are likely to create scientific value.

⁷ List last updated as at the issuance date of this document, subject to change. Applicants should consult the ANR website.

Note: Outside the scope of such bilateral agreements, it is also possible to submit a proposal for a project involving a French team's collaboration with one or more foreign teams from any country desired. In such a case, the foreign team(s) involved will need to ensure their own funding, via their own financial resources or via national funding. In this case, submitting an application under the generic call of proposals, the French researcher will have to use the **PRC** or **PRCE** instruments referred to above, and not the PRCI instrument, which is reserved solely for collaborative projects carried out under bilateral agreements between the ANR and foreign agencies.

B-2) INSTRUMENTS SPECIFICALLY FOR INDIVIDUALS

B-2-1) Young researchers (JCJC)

The objective of the *Young researchers (JCJC) instrument* is to prepare a new generation of talented researchers who are likely to become the future leaders and directors of French scientific research. It also aims to encourage young researchers to take responsibility and to tackle scientific or technological hurdles in an innovative fashion.

This instrument aims to promote young researchers' empowerment and their acquisition of a project mode mindset, while enabling them to develop their own research topic areas independently, to set up or consolidate a research team, and to give them the opportunity to quickly express their innovation capacities.

It is also a springboard for young French researchers who, thanks to an initial ANR grant, will find it easier to consider the possibility of submitting a proposal in response to ERC calls for proposals and with improved chances of success.

This funding instrument is available to researchers who have earned a doctorate (or any credential that meets the international standard for doctorates) within the past ten years, i.e. after 31 July 2004. There is no age limit. As this instrument is aimed specifically at individuals, it provides funding solely for the young researcher's team, and not for possible partners or for collaboration.

The reviewers involved in the evaluation process for JCJC projects will evaluate the soundness of the young researcher's decision to develop his scientific autonomy. The reviewers will not confine their evaluation merely to verification that the scientific coordinator successfully defended his or her doctoral thesis, but will also look at the project's scientific objectives. Projects involving areas that have been extensively worked within the host research laboratory do not fall within the scope of this instrument.

C. Submission, evaluation and selection for the generic call for proposals

Proposals concerning the major societal challenges or the All-Knowledge challenge submitted under the PRC, PRCE or JCJC instruments (voir § B) in response to the **generic call for proposals** will be handled in accordance with the submission, evaluation and selection procedures described in sections C.1 to C.4. Proposals concerning international collaborative research that falls within the scope of bilateral agreements will likewise be subject to the generic call for proposals, but will be evaluated using a separate procedure (see section C.5). The procedures described below do not apply to **other WP 2015 programmes and calls for proposals** (including Challenge Competitions, OH Risk, LabCom, Industrial Chairs, Carnot, Hosting High-Level Researchers, MRSEI, Astrid and so on), nor to specific European and international calls for proposals such as ERA-NETs or JPIs, for each of which specific call for proposals documents will be issued. Concerning these 2015 calls for proposals, it is recommended to the applicants to consult the specific timelines and call texts on the ANR website.

C-1) GENERAL DESCRIPTION OF THE EVALUATION AND SELECTION PROCESS

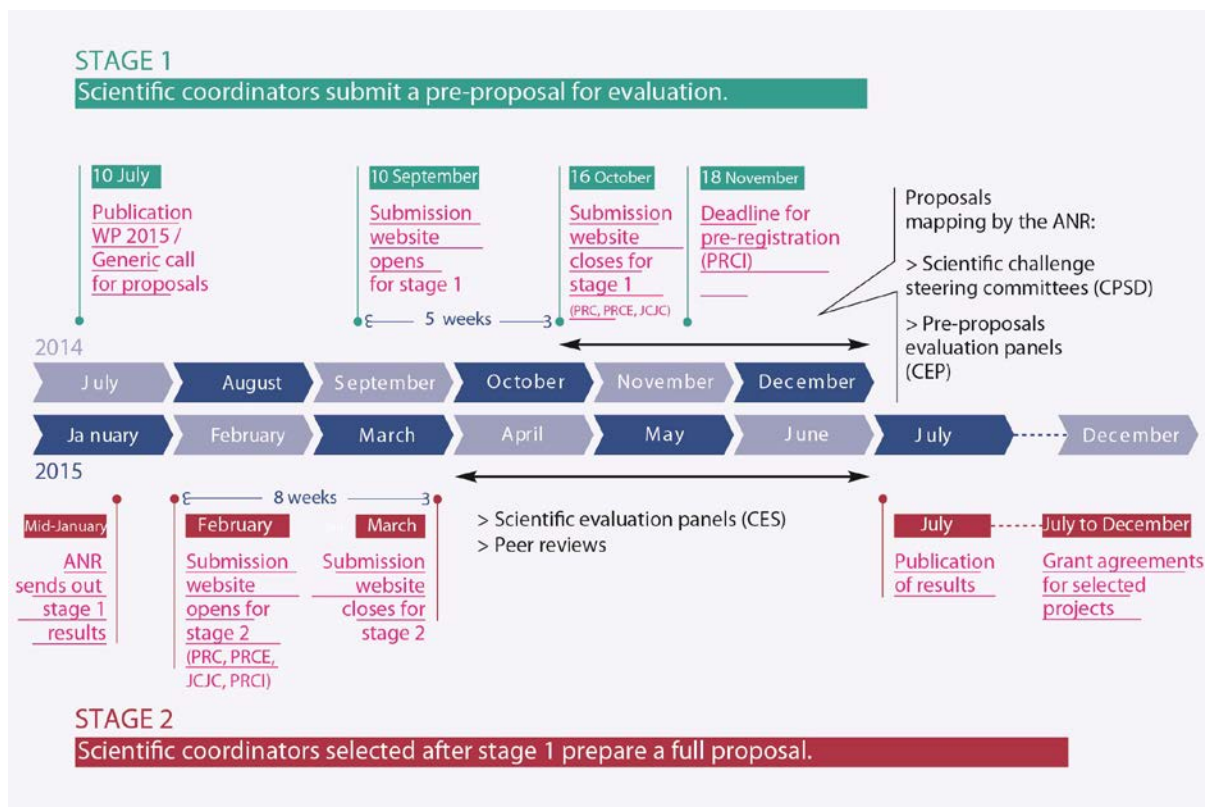
Proposals submitted under the generic call for proposals (**apart from PRCI**) will be selected in **two stages**. The first stage will aim to identify, on the basis of a brief pre-proposal, 2,500-3,000 projects that will be invited to submit applications for the second stage. This applies to both major societal challenges and the All-Knowledge challenge. During the second stage, the projects that are to be funded will be selected on the basis of a full proposal. The evaluation criteria for the two stages differ from each other and are described in detail as follows: in section C.3 for pre-proposals and in section C.4 for full proposals.

Owing to the timeline constraints imposed by the bilateral agreements, applicants wishing to submit a **PRCI proposal** will need to pre-register their project on the ANR website, and will be asked to submit their full proposal concurrently with proposals for PRC, PRCE and JCJC projects. PRCI projects will then be selected during the second stage only, based on a full proposal and the procedures described in section C.5.

The general evaluation and selection process will be carried out by the following entities:

- **Scientific challenge steering committees (CPSD)**, which will be composed of top strategic peer reviewers, Alliances representatives, international peer reviewers, businessmen, representatives of competitiveness clusters, and institutional representatives (from ministries, agencies) that are representative of the challenge.
- **Pre-proposals evaluation panels (CEP)**, which will be composed of experienced individuals who have a big-picture view of the fields of research that are connected with the major challenges and who have hands-on research experience.
- **Scientific evaluation panels (CES)** composed of qualified public or private sector French or foreign individuals from the challenge related research fields.
- **Peer reviewers specialised in the relevant project related field or fields**, who will be appointed, based on recommendations from CES members, and who, via a dedicated interface, will provide written evaluations for one or more projects without participating directly in actual panel work.
- **Competitiveness clusters**, which will be involved in the overall submission, evaluation and selection process and will play a specific role during each stage.

The graphic below provides an overview of the submission, evaluation and selection process.



General overview and preliminary timeline of the two-stage submission, selection and evaluation process

C-2) SUBMISSION OF PRE-PROPOSALS

Pre-proposals are to be submitted online, to the submission website (address available from the ANR website) by the closing date indicated on the generic call for proposals web page of the ANR website.

- The link to this site will be available on a dedicated generic call for proposals page of the ANR website
- Format and content instructions for pre-proposals and full proposals can be found in the **guide for applicants**, which is available from the generic call for proposals page of the ANR website.

The ANR will ask the various competitiveness clusters to express their opinion concerning pre-proposals requesting their support. These opinions will mainly centre around the following project attributes that are directly related to the areas of expertise of these clusters: removal of barriers; potential opportunities; impact on companies, sectors and regions; and consistency with cluster roadmaps and local specialisations.

C-3) EVALUATION OF PRE-PROPOSALS

The French National Research Agency will evaluate the pre-proposals based on the eligibility criteria specified in section C-3-1 and then will map the applications. This mapping will establish a representation of the pre-proposals submitted for each challenge and will take into account the following information submitted online by the applicants:

- The challenge in question
- The research theme of the challenge
- The funding instrument: PRC, PRCE, PRCI or JCJC
- The main object of the research (OPR), selected from a list specific to each societal challenge
- The main application of the research (APR), selected from a list specific to each societal challenge
- For the All-Knowledge challenge, one or more keywords from the European Research Council (ERC) Panel Descriptors list.

The mapping outcomes will be submitted to the Scientific Steering Committee for each challenge (CPSD), for validation. For the projects in question, information concerning competitiveness clusters will be also submitted to these committees.

Each pre-proposal will be sent to three members of the CEP for the challenge in question, for evaluation in accordance with the criteria indicated in section C-3-2. The members of the CEP will grade each criterion.

The pre-proposals will be ranked using the mean grades given by the CEP members (for information concerning the grading system, see the guide for applicants). The results will be sent to the CPSDs, which will indicate the selection thresholds and thus validate the list of pre-proposals that may result in submission of a full proposal. The French National Research Agency will then shortlist between 2,500 and 3,000 pre-proposals (all challenges included), whose applicants will be asked to submit a full proposal.

The ANR will notify all scientific coordinators of the outcome of this first stage and will ask the shortlisted pre-proposal coordinators to submit a full proposal for stage 2 of the evaluation.

C-3-1) Pre-proposals eligibility criteria

A pre-proposal must meet all of the following criteria:

- The pre-proposal must be complete and must conform with the format specified in the guide for applicants.
- The pre-proposal must meet the specific conditions of the funding instrument selected, as described in the guide for applicants.

Eligibility will be checked by the ANR, based on the information contained in the pre-proposal. Pre-proposals that do not meet the eligibility criteria, including if the ineligibility is due to missing information or misinformation by applicants, will not be evaluated and will under no circumstances result in a full proposal.

Pre-proposals will be ineligible if multiple pre-proposals are submitted by the same scientific coordinator⁸ in response to this generic call for proposals.

C-3-2) Pre-proposals evaluation criteria

The CEP members will evaluate the pre-proposals in light of the challenge in question and the orientations of the call for proposals, in accordance with the following evaluation criteria (also see the guide for applicants):

- Relevance and strategic nature of the project
- Potential of the scientific and/or technological objectives
- Consistency of the pre-proposal

C-4) EVALUATION OF FULL PROPOSALS

Applicants who are asked to submit a full proposal will have about eight weeks to prepare them. Full proposals are to be submitted online, to the submission website (address available from the ANR website) by the closing date indicated on the generic call for proposals web page of the ANR website (provisional date: 30 March 2015). Instructions for the preparation of full proposals can be found in the guide for applicants and on the generic call for proposals web page.

Applicants may, if warranted, seek the advice of competitiveness clusters in preparing full proposals. The competitiveness clusters must confirm their label by the full proposal submission deadline.

Following the closing date for the submission of full proposals, the ANR will check their eligibility according to the criteria described in section C-4-1, and if necessary will seek advice from scientific evaluation panel (CES) members.

The full proposals will then be evaluated by CES members, who will take into account the relevant peer reviewer opinions. The evaluations of full proposals will be based solely on the criteria set forth in section C-4-2 of this document. Information concerning support from competitiveness clusters is to be submitted to the CES's.

The full proposals selected for funding by the French National Research Agency will be posted on the Agency website. The ANR will notify to all scientific coordinators the outcomes of this second stage. Grant agreements will be signed between the Agency and beneficiaries according to the regulations concerning the conditions of allocation of Agency funding, which are available on this web page: <http://www.agence-nationale-recherche.fr/RF>.

⁸ A scientific coordinator is an individual who initiates the pre-proposal and agrees, if the project is funded, to take on the role of scientific leader for the coordinating partner as defined in the ANR funding regulations <http://www.agence-nationale-recherche.fr/RF>

C-4-1) Full proposals eligibility criteria

A full proposal must meet all of the following criteria:

- The proposal must be complete and conform with the format specified in the guide for applicants.
- The proposal must meet the specific conditions of the funding instrument selected (see the guide for applicants).
- The statements made in the full proposal must be consistent with those made in the pre-proposal that was shortlisted during stage 1.

The administrative and financial information contained in the full proposals of each partner **is to be signed by the legal representative of each partner that wishes to receive funding**. Thus, applicants should confirm, as soon as possible, that they will be able to obtain these signatures by the closing date for the submission of stage 2 applications.

Eligibility will be checked by the ANR on the basis of the information contained in the full proposal. Proposals that do not meet the eligibility criteria, including if the ineligibility is due to missing information or misinformation by applicants, will not be evaluated and shall under no circumstances be funded.

Full proposals will be ineligible if the ANR considers them to be:

- similar⁹ to a project already funded or being evaluated as part of a call for proposals under the ANR's programme framework,
- non-unique¹⁰.

C-4-2) Full proposals evaluation criteria

Ad hoc peer reviewers and members of the CES will be asked to evaluate full proposals according to the following evaluation criteria (see guide for applicants):

- Scientific excellence and/or innovative nature for technological research
- Project's structure and feasibility
- Overall impact of the project

The peer reviewers may comment on any discrepancies between a full proposal and the counterpart pre-proposal. The CES members in question will indicate whether the full proposal is consistent with the counterpart pre-proposal. If any discrepancies between the two are deemed significant, the CES may disqualify the proposal from further consideration, even if the other criteria receive high marks from the peer reviewers.

⁹ Similarity is established when two full proposals (in their entirety or in part) describe the same main objectives, or are a mere adaptation, AND involve mostly the same teams.

¹⁰ Non-uniqueness is established when the full proposal borrows or copies, in whole or in part, earlier writings whose sources have not been quoted

C-5) SUBMISSION PROCEDURE FOR INTERNATIONAL COLLABORATIVE RESEARCH PROJECTS (PRCI)

International collaborative research projects (PRCI) will be selected **in a single stage, for which applicants will be required to pre-register (pre-registration procedure)**.

Applicants will not be required to submit a pre-proposal. However, they will need to pre-register, i.e. indicate their intention of submitting a PRCI project proposal. This pre-registration is to be effected on the submission website (address available from the ANR website) prior to the 18 November 2014 deadline. These applicants will then be asked to submit a full proposal concurrently with applicants who have opted for the PRC, PRCE or JCJC instruments and who were selected during stage 1.

The eligibility criteria are exactly the same as for full proposals submitted under the other instruments of the generic call for proposals (see section C-4-1), plus additional criteria for specific countries. These additional criteria are described within the **annexes** available from the dedicated generic call for proposals page of the ANR website.

Full proposals will be evaluated concurrently with the full proposals submitted under the other funding instruments of the generic call for proposals, based on identical evaluation criteria (see section C-4-2). The following **additional criteria** will also be evaluated by ad hoc peer reviewers and CES members:

- Balance of the respective scientific and financial contributions of the partners from each country
- Added value of the international cooperation and possible benefit for France.

Once the full proposals have been ranked by the scientific evaluation panels, the French National Research Agency will compare the results of this selection process with the results of the processes conducted by foreign funding agencies. The two additional criteria will be incorporated into discussions with the foreign funding agency, with the goal of arriving at a joint list of projects that are to be funded.

D. Generic call for proposals challenges

Introduction

The 2015 Work Programme generic call for proposals lists nine of the ten societal challenges defined in the National Research Strategy (SNR), plus the All-Knowledge challenge (not included in the SNR). These challenges were elaborated collaboratively, in a manner that took the following into account in particular: the priorities indicated by the workshops that were held for purposes of elaborating the SNR¹¹; the input from the five national thematic alliances¹², the CNRS, the relevant ministries¹³, and the 2015 Work Programme scientific steering committees, which are made up of French and foreign peer reviewers, industrial stakeholders, and institutional representatives.

The challenges pertain to basic, finalised and applied research, cognitive research on basic mechanisms, and research based on the following priorities constituting major challenges:

- Societal challenge no. 1: efficient resource management and adaptation to climate change
- Societal challenge no. 2: clean, secure and efficient energy
- Societal challenge no. 3: industrial renewal
- Societal challenge no. 4: life, health and well-being
- Societal challenge no. 5: food security and demographic challenges
- Societal challenge no. 6: Sustainable mobility and urban systems
- Societal challenge no. 7: information and communication society
- Societal challenge no. 8: innovative, inclusive and adaptive societies
- Societal challenge no. 9: freedom and security of Europe, its citizens and its residents
- All-Knowledge challenge

Major societal challenges and At the frontiers of research components

The nine societal challenges, which are part of the major societal challenges component of the 2015 Work Programme, aim to promote thematic, multi-disciplinary and inclusive research on all major societal issues.

The All-Knowledge challenge is part of the At the frontiers of research component, whose aim is to afford all scientific communities the opportunity to finance projects that clearly do not fall within the scope of the societal challenges.

Research projects for these ten challenges need to be collaborative in nature (PRC, PRCI, PRCE), or carried out by young researchers (JCJC).

¹¹ <http://www.enseignementsup-recherche.gouv.fr/cid78802/strategie-nationale-de-recherche-bilan-des-travaux-des-10-ateliers.html>

¹² Allenvi, Allistene, Ancre, Athena, Aviesan

¹³ Ministries in charge of: research and higher education; agriculture; ecology; healthcare; industry, defense; foreign affairs; culture, national education

Building the European Research Area (ERA) and France's international attractiveness component

All of the 2015 Work Programme challenges are also part of the *Building the ERA and France's international attractiveness* component. For French teams, this means facilitating the establishment of consortiums, including foreign teams, by in particular taking advantage of bilateral or multilateral agreements that have been concluded between the ANR and funding agencies in Europe or elsewhere. Detailed information concerning the European and international partnerships envisaged for 2015 in connection with the generic call for proposals challenges (bilateral partnerships, ERA-NETs, JPIs, Belmont Forum and so on) can be found in the box that appears at the top of the first page of each challenge description. As for the *international collaborative research project (PRCI)* instrument of the generic call for proposals, it promotes the development of top-drawer collaborative teams of French and foreign researchers, based on existing partnership agreements between ANR and another foreign agency (European or non-European).

Economic impact of research and competitiveness component

The fourth component of the Work Programme 2015, which is known as *Economic impact of research and competitiveness*, involves the generic call for proposals via the *collaborative research projects involving enterprises (PRCE)* instrument. It enables teams of researchers to carry out projects as a public-private partnership. Its goal is to facilitate the transfer of academic knowledge to the business sector, in order to promote national competitiveness.

Multi-disciplinarity, cross-cutting and interfaces

The generic call for proposals challenges are inherently multi-disciplinary. In the light of the challenges faced by today's society, it is becoming increasingly necessary to take advantage of various types of expertise and know-how in an integrated fashion.

In addition, there are various cross-cutting research topics involving multiple challenges. These topics were defined for the most part during the mapping process that was carried out based on the pre-proposals submitted in 2013 (generic call for proposals for the 2014 Work Programme). In the interest of enabling applicants to determine which challenge is most suitable for their project, a non-exhaustive list of cross-cutting topics was elaborated:

- Topics which, depending on the subject of the study in the question, fall within the scope of two challenges are listed in the box that appears at the beginning of the relevant challenge section, with cross-references to any other relevant challenge (see the interface item for each challenge).

- Other cross-cutting topics can be handled very broadly (depending on the subject of the study) for most of the challenges. These challenges are described in detail below and are indicated, solely as a reminder, in the box that appears at the top of the first page of each challenge description (see the interfaces item).

Applicants should read the entirety of the challenge sections in question so as to familiarise themselves with their exact attributes. Depending on the context or end point of your particular

research project, and having regard to the societal issues discussed in each of the challenges, it is up to each applicant to embed their project in the challenge that is most consistent with the project.

BIG DATA

Applications for research projects involving big data, simulations, modelling, or high performance computing should be submitted under **all challenges**.

Pre-proposals involving experimentation or modelling fall within the scope of the **societal challenges** that apply to the relevant application domain (climate/environment, energy, industry, health, food, global security and so on). Pre-proposals involving interdisciplinary teams, big-data processing, and high performance computing fall within the scope of **challenge 7** (theme 8, i.e. *big data and high performance computing: challenges and synergy for digital simulations*); also see the report from the workshop on prospective thinking, available from <http://mathsinterre.fr>. Pre-proposals involving the gathering and analysis of interaction related big data, the extraction of knowledge for purposes of understanding or making forecasts, or decision making support likewise fall within the scope of **challenge 7** (*MMI, connected objects, digital content, knowledge, and big data*).

BIOLOGY

Basic or applied research in the field of biology can fall within the scope of the following **challenges: 1, 2, 4, 5, 9** and the **All-Knowledge challenge**.

Basic research that aims to gain an understanding of general biological mechanisms and that does not focus on practical applications is to be submitted under **challenge 4**, as is prior (upstream) research concerning the development of generic research tools that pertain to multiple application domains. Research involving practical applications for humanity (including long-term research) are likewise to be submitted under **challenge 4**. Basic or applied bioenergy research (including long-term research) is to be submitted under **challenge 2**. Basic or applied research pertaining to the production of alimentary or non-alimentary products is to be submitted under **challenge 5**. Research projects that pertain to biodiversity evolution and services have to be submitted under **challenge 1**. Research pertaining to biological threats (agents, detection, counter-measures, crisis management and so on) is to be submitted under **challenge 9**. Aspects of basic biology that do not fall within the scope of the nine societal challenges are to be submitted under the **All-Knowledge challenge**.

BIOTECHNOLOGY

Biotechnology research falls within the scope of challenges **1, 2, 3, 4 or 5**, depending on the research field and the applications involved.

Human-health related biotechnology research projects are to be submitted under **challenge 4**. Biotechnology research projects that aim to produce advanced biofuels are to be submitted under **challenge 2**. Biotechnology research involving the use of alimentary or non-alimentary bio-resources falls within the scope of **challenge 5**. Research that aims to optimise or develop bio-processes for industrial applications, or compounds or innovative products for therapeutic or other purposes, are to be submitted under **challenge 3**. Projects that aim to remediate environmental compartments or develop environmental sensors are to be submitted under **challenge 1**.

HEALTH AND ENVIRONMENT

The French National Research Agency aims to facilitate the realisation of projects encompassing the environment, ecosystems, and population and anthropisation for a holistic vision of health under the One Health approach, particularly in the fields of emerging diseases and toxicology/eco-toxicology. Applications for such projects may be submitted under **challenges 1, 4, or 5**, depending on the subject of the study concerned.

Research that centres on humanity, toxicology, zoonotic pathologies and prophylactic medicine falls within the scope of **challenge 4**. Projects centring around (a) the role played by the environment in emerging diseases; and (b) the relevant plant or veterinary dimensions are to be submitted under **challenges 1 or 5** (for exploited ecosystems). Ecotoxicology, metrology of environmental contamination, and remediation fall within the scope of **challenge 1**. Studies pertaining solely to exploited ecosystems or contamination of the food supply fall within the scope of **challenge 5**.

SENSORS

As from the proof of concept, research centring around dedicated sensors for a specific application domain (e.g. environment/climate, energy, health, food, global security) are to be submitted under **challenges 1, 2, 4, 5 or 9** respectively.

Applications concerning sensor research in the ICT domain (**challenge 7**) are to centre around the design and manufacture of sensors using nanotechnologies, and sensors with nano-measurement capacities. **Challenge 7** also involves inter-sensor communication mechanisms and protocols, as well as interactions between connected objects. Research centring around the performance (sensitivity, selectivity and the like) of physical, chemical or biological sensors for factories, products of the future, and industrial metrology (e.g. gas sensors and detectors) fall within the scope of **challenge 3**, except for NRBC-E¹⁴ agents, which fall within the scope of **challenge 9** and environmental applications, which fall within the scope of **challenge 1**.

ROBOTICS

Industrial-robotics research centring around a technological element or a complete solution, and regardless of whether basic, industrial or experimental research is involved, falls within the scope of **challenge 3**.

Dedicated robotics projects for any other specific application domain and for which the scientific and technological bases do not constitute the main research priority, fall within the scope of the relevant challenge, namely climate, environment, healthy, agriculture, transportation, global security: **challenges 1, 4, 5, 6 or 9** respectively. Digital robotics research (**challenge 7**) is to centre around basic research and integrative research entailing multiple application domains. **Challenge 7** also involves inter-robot communication mechanisms and protocols, as well as interactions between connected objects.

¹⁴ NRBC-E = threats of a nuclear, radiological, biological, chemical or explosive nature

D-1) CHALLENGE 1 - EFFICIENT RESOURCE MANAGEMENT AND ADAPTATION TO CLIMATE CHANGE

INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATIONS

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in [table 1 \(§F\)](#). The following countries come into play for this challenge:

- China (water management and purification)
- Turkey (marine geosciences, seismic risks, marine ecosystem mechanisms)
- Brazil (marine research)

A list of additional European and international calls for proposals under the generic call for proposals can be found in [table 2 \(§F\)](#) ; the following elements come into play for this challenge:

- Belmont Forum CRA on “Arctic Observing and Research for Sustainability”; on “Scenarios of Biodiversity and Ecosystem Services”; on “Transformations to Sustainability”;
- JPI Climate/Belmont Forum “Climate Predictability”;
- JPI Ocean “Ecological Aspects of Micro-plastics”;

=> These lists are provided for informational purposes only, and are subject to change. Applicants who intend to carry out their projects in a European or international context should regularly visit the French National Research Agency website (<http://www.agence-nationale-recherche.fr/en>) to learn more about these partnerships and calls for proposals.

INTERFACES

Some cross-cutting research areas are related to challenge 1 as well as to other challenges. We indicate below the other challenges and areas, so as to help applicants select the challenge that is the most suitable for their research. Applicants should read the complete text of these challenges so as to familiarise themselves with the detailed content.

Big data; biology; biotechnology; health and environment; sensors; robotics

For information concerning these particular cross-cutting areas, which by and large fall within the scope of [multiple challenges \(including **challenge 1**\)](#), see the general introduction in [§ D](#) “Multi-disciplinarity, cross-cutting and interfaces”.

Ecosystems: Research focusing on the study of the mechanisms of exploited ecosystems, their adaptations and the development of innovative sustainable production systems, falls within the scope of **challenge 5**.

Research focusing on non-exploited ecosystems or their interactions with exploited ecosystems and research that revolves around environmental impact and management falls within the scope of **challenge 1**.

Urban areas: Urban areas and urban ecology, which are key factors in climate change, generally fall within the scope of **challenge 6**, provided that the research in question mainly focuses on the specifically urban dimension of a specifically urban problem such as adaptation to climate change, urban agriculture and so on. In the absence of a specifically urban dimension, the application should be submitted under the challenge that pertains to the other aspects of the project.

Environmental risks: Crisis management from an operational, logistical, economic or other standpoint falls within the scope of **challenge 9**. Natural risks and the possible origins of a crisis (e.g. characterisation of the hazard and of the relevant risk factors, observational tools and methods), preventive systems, threat evaluation and alarm thresholds all fall within the scope of **challenge 1**. Geophysical and geodynamic processes that are precursors of telluric hazards fall within the scope of the **all-knowledge challenge**.

Mineral and material resources: Gaining an understanding of mineral raw material deposits falls within the scope of **challenge 1**. Projects pertaining to methods and technologies for the extraction, separation, processing, and recycling of the materials used by energy technologies fall within the scope of **challenge 3**. All research concerning the use of mineral raw materials for energy purposes falls within the scope of **challenge 2**.

Social systems; migration: The socio-political and legal dimensions of environmental migration fall within the scope of **challenge 8**, as do disasters that reveal social divides. The debate concerning the importance of climatic or environmental migration within migration as a whole falls within the scope of **challenge 8**.

Paleo-environments: Projects that have little or nothing to do with the Anthropocene fall within the scope of the **all-knowledge challenge**.

Introduction

In light of world population growth and the stepped-up renewal of requirements for energy, raw materials, products and services, **environmental changes** are becoming an increasingly pressing matter at all levels, **from the landscape to the planetary level** (climate, biodiversity loss, soil degradation, pollution of air, fresh or marine bodies of water, and so on). Integrated management of the environment and of the development paths of human societies in all their diversity is required in this new era, called the Anthropocene.

To address this challenge, we need to gain insight into the mechanisms underlying these changes and their local and regional impacts on resources, human societies and human activities – particularly those that rely on ecosystem services (see the [Millennium Ecosystem Assessment](#)). Facing this challenge will also require social, political and economic innovations to avoid or attenuate or partially compensate impacts, rehabilitate the natural environment, and adapt to the new constraints and

opportunities. This challenge contributes to major international initiatives in this area ([GEO](#), [Future Earth](#), [GFCS](#), [IPCC](#), [IPBES](#), [SDG](#) and so on) and is supported by [Belmont Forum](#) international calls for proposals.

Hence, in the interest of promoting the development of the European Research Area (ERA), this challenge aims to promote French coordination of European projects as follows:

- Firstly, within the framework of **Horizon 2020**, applicants are encouraged to use the **MRSEI funding instrument** (MRSEI is the French acronym for “establishment of European or international scientific networks”) described in section E.7, to prepare proposals for (i) European Research Council (ERC) calls for proposals at the frontiers of knowledge; or (ii) calls for proposals concerning societal [challenge 5](#), i.e. “Climate action, environment, resource efficiency and raw materials.”

- Secondly, in connection with calls for proposals of the **Joint Programming Initiatives (JPI Climate, JPI Oceans, JPI water)** and the related ERA-NETs (such as [BiodivERsA](#)), applicants should inform themselves, via the French National Research Agency website, about the details and latest developments concerning calls for proposals that the Agency is participating in.

Numerous scientific disciplines are expected here: social sciences and humanities; environmental sciences, life sciences and earth sciences; engineering; and in some cases mathematics, information and communication science, and health sciences. We welcome applications within a **broad spectrum of projects**, depending on topic area, ranging from **academic** research to partnerships with **private** sector, **public** sector and **communities**. The challenge is divided in five research themes and 16 research sub-themes, ranging from basic (upstream) research topics to those with multiple applications.

Research theme 1: Understanding and anticipating environmental change

In order to evaluate and predict environmental, global and multi-factor changes, it is necessary to consolidate our **basic knowledge**, based on the dynamic, physical-chemical and biological processes of the **Earth System's** various sub-systems across **various time and spatial scales**. One of the issues here is to foster integrated approaches to environmental problems. We especially encourage proposals concerning **innovative instruments** for laboratory experiments, in situ experiments, as well as in situ or remote observations (for operational sensors, see theme 4).

Functioning and evolution of climate, oceans and major cycles

The climate domain touches upon all of the Earth System's compartments: the **atmosphere** and the **hydrosphere** (including the **oceans** and the **cryosphere**) closely interact with the geosphere, the biosphere and human societies. The challenge here is to gain a better understanding and representation of the relevant processes, and reduce model biases and uncertainties (gas-aerosols-clouds interactions, ocean circulation, marine biogeochemistry, flux drivers and dissipative mechanisms, non-linear or chaotic phenomena, scales and spaces interactions, tele-connections, interfaces between environmental compartments, global cycles of water, of carbon, of nitrogen, and so on).

Global warming, which is chaotic and marked by extreme events, leads us to ask questions about **natural variability** and **distinguishing** between **natural** and **anthropogenic** signals (induced by gas and substance emissions). Studies are encouraged on (i) the use of **proxies** and historical **chronicles** concerning the most **recent millennia**; or (ii) periods long ago where **analogues of rapid transition** help us to gain an understanding of 21st century variabilities and tendencies. Applicants are encouraged to take advantage of the major global **re-analyses** of the Earth System concerning recent decades and centuries, in order to gain greater insight into **regional** variability modes, the related

extremes, and their **predictability**. The scales ranging from the **season** to the **decade**, which are pivotal between seasonal forecasts and climate projections over a century, are crucial to decision making concerning adaptation.

Functioning and evolution of the critical zone (continental land areas)

The critical zone extends from the summit of the canopy to the unaltered geological formations of the near sub-surface. It includes both water-saturated and non water-saturated zones. This zone's multifunctional nature lies at the heart of both exploited and non-exploited ecosystems, by virtue of (a) the fact that this zone provides us with commercial goods and ecosystem services; and (b) this zone's possible feedback to Earth System mechanisms: climate **regulation**, water **transfer**, greenhouse gases, mineral elements, biogeochemical **cycles**, resource **conservation**, soil **fertility**, biodiversity and so on. Various questions arise here concerning the **interactions** between the following: soil and sediment, water masses, the atmosphere, living organisms, linkage of the biogeochemical cycles of major elements, minor elements, and trace elements and contaminants, as well as stable and radioactive isotopes, energy and material transfers (e.g. transport of solids or elements in suspension). Gaining an understanding of critical-zone mechanisms is key in determining the status of **groundwater** resources, of surficial **free waters**, and of the hyporheic area via the relationships between rivers and the water table. Research is needed in the following areas: measuring and modelling the kinetics of **pedogenesis** or **soil degradation** (silting, erosion, mass movements, fertility loss, contamination, salinization and so on); continental **water degradation and renewal processes** (quantity, quality, availability), and the **related biodiversity** processes. In short, there is a need to analyse and model the responses of hydro-systems and soils to **new uses** and to the **pressures of global change**, particularly those related to climate in their interactions with the development of human activities such as farming, urbanisation, and littoralisation.

Functioning and adaptation of species and of natural or anthropised ecosystems (terrestrial, aquatic and marine)

Studying the relationships between climate, biodiversity and (agro)ecosystems, from **landscape to global scales**, will help understand ecosystem **resilience** and capacity generate a range of services. The issue here is to reconcile biodiversity protection, **adaptation** to changes and the support provided by **ecosystem services**, with the maintenance or increase of farm, forest and marine production¹⁵. Basic knowledge regarding **biodiversity evolution** and **population dynamics within ecosystems** (emergence, extinction, colonisation, invasion and so on) is needed, while giving priority to responses to climate and environmental changes, as well as anthropic pressures.

The research expected here will help to gain greater insight into a given system's **capacity for evolution or adaptation**, in terms of its **functional biodiversity**, through analyses of spatial and temporal **interactions**, and interactions **between trophic levels**. This pertains to all types of natural and anthropised ecosystems, as well as to all species regardless of whether they have been modelled and whether they are wild or exploited. In particular, research is encouraged concerning: (i) modifications in the **marine** or **aquatic** environment related to fishery resource issues; (ii) dynamics of **species** (animals, plants and micro-organisms) and **ecosystem adaptation** faced with climatic and environmental change (including in extreme environments); (iii) the **role played by biodiversity** in the stability, resistance and resilience of ecosystems and associated services; and iv) the **impact** on environmental changes of **agroecosystems** and various agricultural **practices** (through the release of components into air, water and soil).

¹⁵ For information concerning intrinsic production parameters, see challenge 5

Knowledge of underground mineral resources

Mineral resources are indispensable for the development of **new technologies**, particularly those involving transportation and renewable energy (energy resources fall within the scope of challenge 2). Even if recycling is optimised, it will not be sufficient to meet the growing needs. Hence **finding** new resources and **exploiting** them while respecting the natural environment are increasingly difficult. A new paradigm is needed when it comes to **potential terrestrial or marine deposits**, particularly in order to respond to new industrial development.

Understanding the **processes** responsible for the **origin** of deposits and mineralisation, from complex fluid **transfers** to successive **deformations of hosts of deposits**, and developing **methods and technologies** to shed light on the structures favouring these accumulations, are indispensable in order to **locate** these resources, **assess** their potential, and **identify** as early as possible potential **obstacles** to their exploitation or **impacts** on the natural environment, ecosystems and biodiversity (also see research theme 5).

Research theme 2: Health risks in the face of environmental change

Recent environmental crises, the impact of pollution and contaminants, the emergence or re-emergence of infectious diseases that could potentially cause pandemics, as well as species conservation are all major causes of concern in terms of **the impact of the environment on ecosystems' health (incl. plants, animals and humans)**. In the interest of gaining a greater understanding of these effects, we encourage applications for research involving **renewed cooperation** between the relevant disciplines (biology, environmental science, climate science, the humanities, social sciences, medicine, veterinary science and so on) so as enable us to gain a greater understanding of the relationships between human health, the health of living species and ecosystem health, via a cross-cutting approach along the lines of **One Health**¹⁶. All of the foregoing falls within the scope of challenges 1, 4 and 5.

Challenge 1 centres around the role of **environmental change** (including climate change and pollution) and **ecosystem dynamics** in the emergence of health risks. We are looking for research that will yield useful insights into integrated policies in the field of public health (including plants and animals).

Ecotoxicology

Ecotoxicology is a multi-challenge cross-cutting topic area. The kinds of research we are looking for are described under challenge 1 below.

- **Transfer and impact** of physical, chemical and biological contaminants in respect to various environmental compartments (air, water, and soil).
- The **eco-dynamics** of contaminants and their transformation metabolites and products; determination of **bio-indicators and bio-markers**.
- **Contributing to the determination of the exposome**¹⁷ by including contamination as a habitat variable in the life cycle of individuals found in populations and communities, and assessing the related ecotoxicological risks (including long-term low dose **cocktails**).

¹⁶ J. Zinsstag et al. (2011) at <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3145159>

¹⁷ <http://www.allenvi.fr/content/download/4129/31056/version/4/file/Rapport+IFRES.pdf>

Emerging diseases and the environment

This topic involves the evaluation of health risks related to environmental change (including climate change), and gaining greater insight into the relevant mechanisms, including those that promote the **emergence or re-emergence of disease** (incl. plant, animal and/or human). This pertains to the risks arising from chemical, physical or biological agents.

The focus here is on **agents of biological origin** as well as pathogen virulence, dissemination, vectors and hosts. We are looking for multi-disciplinary and integrated approaches (encompassing the fields of environmental studies, biology, veterinary medicine, the humanities, and the social sciences) on the following:

- Pathogen **origins**, ecological **niches** (reservoirs and vectors), their development **conditions**, and their spatial and temporal **dynamics**.
- **Interaction mechanisms** between climate, biodiversity loss, and anthropic factors that promote **virulence** and **dissemination**.
- **Modelling** parameters related to emergence, dissemination and exposure, and establishing **databases** or **observing systems** that interconnect health and the environment and that will help to define the **relevant indicators**.
- **Countermeasures and the related methods** that are safe for the environment and human health.

Research theme 3: Society in the face of environmental change

Environmental impacts need to be mitigated by means of suitable **development and governance modes**. The task here is to collaboratively explore the following: the vulnerabilities and opportunities arising from environmental, **social, political and economic** changes; the conditions under which various societies adapt to these constraints; and the perspectives for action. Research in such areas may address various temporal and spatial levels, depending on whether a sectorial, inter-sectorial or international approach is adopted.

Renewal of forms of action and instrument of intervention

Taking into account the problems depends both on their acuity and on how they are addressed by **stakeholders in the public, private, social and economic realms**. Which problems have a structuring effect on discourse and proposals and disseminate these elements – and to what effect, in terms of reconfiguring power relationships, coalitions, action related thinking and spaces? Under which conditions do environmental problems become public problems (justification and hierarchy-creating modes, knowledge production and dissemination modes, controversies in the face of uncertainty, and so on)?

Environmental policies and the **forms of action** can be analysed on the basis of their elaboration modes, their content, their implementation, and learning and cooperation modes. Which instruments are used (consultation, incitation, law and so on)? How are regulations and technical measures interlinked? The interrelationships between the various policies warrant exploration (environment, health, agriculture, commerce, industry, innovation and so on). We would particularly welcome projects that will allow for the elaboration of **evaluation tools** and for proposing **mechanisms that promote collective action**.

Geopolitical aspects; forms of cooperation; international negotiations

Environmental change can potentially give rise to new **geopolitical power relationships** and **conflicts**. Conversely, certain confrontations may accentuate the effects of these changes. The interplay between **developmental modes, the environment, vulnerability and international relations** could potentially be explored. Which collaborative arrangements and solidarity mechanisms could be used? What forms should national sovereignty and international governance take? The connections or interferences between various topic areas and entities warrant particular attention (IPCC, IPBES, UNEP, WTO, IMF, G20, etc.).

Vulnerabilities, capacity for resilience and adaptation on the part of societies

As a result of the effects of climate change, ad hoc approaches for a given hazard are being abandoned in favour of **long term** development of **multi-risk, inter-sectorial and integrative approaches** that take the domino effect into account. Various kinds of risks come into play here: physical, technical, organisational, institutional and social risk, to name but a few. The concept of resilience allows for the qualification of **capacities for resistance and adaptation** on the part of today's societies. **Organisational structures** are a determining factor for **vulnerability** and **resilience**. Which sociocultural factors allow for adaptation to extreme or long-term events? Historical and retrospective approaches should promote an understanding of these phenomena. What role do memory and knowledge of people play in differing cultural settings? How can long-term factors be taken into account in light of the temporalities arising from other spheres of life in society: finance, infrastructures, innovation, policy, lifestyles and so on? Which systems are and could potentially be the most relevant systems that promote accountability, protection, insurance and repair?

Management, production and consumption modes; new growth modes

In order for sustainable development to be achieved, change needs to be effected through a multi-sectorial approach, in conjunction with **management, production, and consumption** modes. Which options should be envisaged, in light of the existing constraints and determinisms? How can innovative stakeholders integrate themselves with existing stakeholders? Which dynamics will allow for the development of markets, new industries and so on? Which instruments will allow for the adaptation of production and consumption behaviours (certification, labelling, regulations, good practices, and so on) and forms of economic organisation? How reconcile land management, environmental management and competitiveness? Areas warrant new investigations as the interplay between growth, development, and taking the following into account: environmental change, the reduced impact and growing scarcity of certain natural resources (new impetuses for growth, incentives for growth development in keeping with these objectives, the role of industrial policy.

Research theme 4: Scientific and technological innovation aimed at anticipating or remedying environmental risks

Environmental problems entail (a) preventive challenges aimed at reducing waste of environmental change or facilitating adaptation to it; (b) curative challenges, aimed at remedying environmental compartments; and (c) preventive challenges for risk reduction purposes (the circular economy which is related to new industrial sectors, falls within the scope of challenge 3). **Public-private partnerships** should be prioritised so as to **avoid, reduce, or compensate** for environmental risks, in respect of the following 2015 priorities:

Development of sensors for the monitoring of environment (smart monitoring)

Underestimating the heterogeneous nature of the environment limits the contribution of conventional metrology and the efficiency of numerous preventive and protective solutions. In order to take this heterogeneity into account, a **new generation of long term observation systems** is needed. Thus we are looking for **technological, economic and methodological breakthroughs** that allow for cost reductions, miniaturisation, sensor autonomy and reliability, data-flow increases, and so on. We encourage applications for projects involving the development of **green sensors**. In this diversified field of innovation involving numerous types of businesses, we are in particular looking for **technology transfers** that are enabled by information and communication science and technology (robots, drones, nanotechnologies, bio-mimetics, big data and crowd sourcing related solutions), the life sciences (biotechnology), and the geo-sciences (geophysics, geo-chemistry, and remote detection). When it comes to applications for natural or man-made environments, all environmental compartments come into play: **aquatic, marine, coastal, air and soil** components and their biotic and abiotic components.

Methods and tools for operational alert and environmental crisis services

When it comes to predicting and managing environmental alerts and crises, it is often claimed that natural and/or man-made risks yield synergy or “cascade” effects (pollution, ground movements, volcanic eruptions, fires, storms, droughts, heat waves, water over-exploitation, etc.). We are looking for research on methods and tools for **dedicated operational services** for these multiple risks and that integrate data **modelling** and **assimilation tools**. (Excluded here are climate forecasting services and century-related seasonal forecasting services, which fall within the scope of research theme 1 above). Such advances would allow for the management of multi-source information and large information flows in real time or quasi real time, with the goal of gaining a better knowledge on the mechanisms and conditions entailed by alerts that are issued in good faith.

Proposals concerning **integrated forecasting systems** that yield information and scenarios based on the possible origins of a given crisis or disaster are encouraged. Here, the interconnection of multiple alert systems would be co-ordinated with the stakeholders and users concerned. Depending on the fields involved, forecasting systems should focus on periods ranging from a few days to a few months, and on areas that may range in size from a town, to a large region, or to Europe as a whole.

Methods and technologies for sustainable remediation, technological engineering, and climate engineering

The priority in terms of remediation is to restore soil, sediment, biodiversity, water, water service, and climate engineering quality. The goal is to advance the concept of curative treatment toward more systemic and **sustainable remediation** concepts, and to implement integrated strategies concerning primary needs, while still meeting societal needs (air, water, energy, and land, as well as carbon sequestration and the like) via a favourable cost-benefit ratio. Based on **ecological engineering tools** and **new technologies** (e.g. biotechnology, nanotechnology, geophysics, hydro-bio-geochemistry), incorporating technology chains centring around the capacity of products to be recycled will lay the groundwork for **new forms of hands-on engineering**.

In the **contaminated site domain**, we encourage research on new processes and/or combinations of remediation measures with a **positive environmental balance sheet**, with the goal of establishing **pedo-genetic engineering practices** that are conducive to deployment in urban and/or de-industrialised areas.

In the field of **water**, preference will be given to proposals that pave the way to breakthroughs aimed at designing the putative **waste water treatment plant of the future**, integrating the following in

particular: recovery of raw materials derived from the relevant treatments; taking emerging pollutants into account; and greater energy efficiency.

When it comes to the **greenhouse effect**, the programme aims to develop French expertise in the field of **climate engineering** (see www.arp-reagir.fr) particularly for the following: (a) management of solar radiation and their impact, which is often negative; and (b) **capturing atmospheric or marine carbon**. For this latter element, we are looking for the following: (a) inventive so called **second intention carbon sequestration solutions**, which could be grafted onto existing industrial processes; (b) **“territorial” geo-engineering**, or using soil to help improve local climatic conditions; and (c) **climate oriented agriculture**.

Research theme 5: Integrated approaches to environmental development: toward more efficient solutions

Issues concerning efficient resource management and adaptation to climate and environmental change can only be addressed by taking account of the **complex interactions between ecosystems and socio-economic systems**, in other words within socio-ecosystems.

Cross-cutting research on previous themes should contribute to the development of more efficient solutions in the context of sustainable development. We strongly encourage applications on this challenge.

Integrated or systemic research should allow for characterisation of and differentiation between the various components of the relevant compartments, sectors and stakeholders, and the interplay between them. We recommend that projects with a **common aim** indicate, within the envisaged conceptual framework, the interconnections within the system selected (i.e. feedback, synergy, and compromises) and their boundary limits (i.e. what is exterior to the system).

We are particularly looking for integrated projects that are **multi-disciplinary, inter-disciplinary or trans-disciplinary** in nature. Particular attention will be devoted to projects involving **science users**¹⁸ in conjunction with whom projects can be designed (e.g. short term exploratory projects promoting the establishment of inventive consortiums, major integrated projects on issues that have already been raised, etc.).

Ecosystem services, conflicts and compromises

Ecosystem services encompass **numerous aspects**, ranging from **supply** services (e.g. food, fibres, useable compounds, genetic resources, etc.) to environmental **regulation** and **self-maintenance** services (e.g. climate, water, carbon, nutritional elements, oligo-elements, metals, etc.) and **cultural** services. **Identifying, quantifying and evaluating** these elements (commercial and non-commercial values) fall within the scope of a thriving research field that is upstream from the intergovernmental platform **IPBES** concerning biodiversity and ecosystem services.

We are looking for proposals in this field, in particular concerning the **analysis of usage conflicts** between various ecosystem services (e.g. biodiversity conservation versus carbon storage, energy resources versus cultural heritage, purification or buffer roles versus productivity, etc.), concerning the emerging process of compromise between the relevant stakeholders, and the emergence of new concepts (e.g. virtual water and water footprint). We are also looking for **retrospective studies**

¹⁸ From the public or private sector or communities

covering several decades, or a century (e.g. the establishment of national parks and the changes in the living conditions of populations).

Regional/national land management and resilience (coastal areas in particular)

In order to achieve more sustainable development, the cumulative environmental effects of human activities need to be mitigated but societies need also to adapt themselves in a manner that strengthens their resilience. This in turn will require more efficient **regional/national management**¹⁹ in the **medium to long term**. We are looking for **inter-disciplinary and trans-disciplinary** consortiums that are composed of public and private sector stakeholders since the project design phase; and that will investigate problems related to a shared region. The involvement of **actors and decision makers** in regional/national land and sea **use planning** is encouraged, so as to insure a genuine synergy and a knowledge transfer.

In this regard, the priority zones for 2015 are as follows:

- **Coastal areas:** of catchment basins whose waters flow into the sea, estuaries, deltas, interfaces between continental, river and marine compartments, changes in upstream fluvial regimes combined with ocean level variations, littoralisation, and so on.
- **Southern countries**²⁰ **and overseas regions:** the areas that are most vulnerable to environmental change but that have the lowest capacity for adaptation.
- **Urban areas:** see challenge 6.

Toward a reduced impact on new economic sectors

The development of green growth hinges on the creation of **new economic sectors** (e.g. industry, energy, agriculture, mining including storage, etc.) in a manner that protects the environment and that is based on **ecologically sound** use of primary resources and judicious **treatment of emissions and wastes**. These changes need to enable us to transit from remediation (see research theme 4) to the preservation and management of common goods.

Thus, within this framework of the development of these new sectors, specific research needs to be conducted from a preventive standpoint, in order to **analyse and avert** the potential **impact** and environmental **risks** lying outside the delimited scope of sectorial activities²¹; and to **identify recommendations** to minimise the impact on environmental compartments (water, air, soil, sub-surface, biodiversity, ecosystems, climate, etc.). Such recommendations should centre around elements such as the following:

- **Sustainability conditions** for primary resources and the compartments in which they are found.
- **Scenarios of pressure and impacts** on environment from these new sectors, including **long-term** trends.
- **Identification** of key elements for the **monitoring** of potential impact (possible connection with research theme 4).
- **Pre-regulatory orientations** aimed at preserving the quality of environmental compartments and their resources.

Crisis management scenarios, analogue models could help to support the structuring of this preventive research.

¹⁹ Typically ranging from the landscape or small-basin scale to that of a large region

²⁰ We welcome projects with scientists' involvement in southern countries, combined with the possibility of supporting the bolstering of capacities for less developed countries

²¹ Within the framework of physical installations that carry out such activities, environmentally friendly solutions fall within the scope of the challenge in question.

D-2) CHALLENGE 2 - CLEAN, SECURE AND EFFICIENT ENERGY

INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATION

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in [table 1 \(\\$F\)](#). The following countries are particularly relevant for this challenge:

- Germany, Austria, Switzerland
- Canada
- Taiwan, Hong Kong, Singapore, India (engineering sciences).

A complete list of European and international calls for proposals under the generic call for proposals can be found in [table 2 \(\\$F\)](#); the following elements come into play for this challenge:

- ANR-JST Japan “From molecular technology to functional materials”;
- ERA-NET MED;
- AAP NSF ANR PIRE programme (Partnerships for International Research and Education)

=> These lists are provided for informational purposes only, and are subject to change. Applicants who intend to carry out their projects in a European or international context should regularly visit the French National Research Agency website (<http://www.agence-nationale-recherche.fr/en>) to learn more about these partnerships and calls for proposals.

INTERFACES

This challenge encompasses cross-cutting research areas for other challenges. We indicate below the other challenges that these topic areas fall within the scope of, so as to help applicants select the challenge that is most suitable for their research. Applicants should read the entirety of the challenge documents in question so as to familiarise themselves with their exact attributes.

Big data; biology; biotechnology; sensors

For information concerning these cross-cutting areas, which by and large fall within the scope of multiple challenges (including challenge 2), see section D “Multi-disciplinarity, cross-cutting and interfaces” in the general introduction to the said section.

Environmental impact Quantification of the overall impact (e.g. water consumption, carbon emissions) of energy systems falls within the scope of **challenge 1**. Concepts concerning energy

technologies that have a lesser environmental impact, as well as research on the management and prevention of risks induced by energy technologies, fall within the scope of **challenge 2**.

Mineral and material resources: The generation of knowledge concerning mineral deposits falls within the scope of **challenge 1**. Projects pertaining to methods and technologies for the extraction, separation, processing and recycling of the materials used by energy technologies fall within the scope of **challenge 3**. Research on the use of mineral raw materials for energy applications falls within the scope of **challenge 2**.

Nuclear research: Research on materials that are subjected to extreme operating conditions such as those found in the nuclear sector falls within the scope of **challenge 3**. Matters related to digital simulations falls within the scope of **challenge 7**.

Biomass and bioresources: Multi-use approaches for biomass whose main purpose is not specifically energy related (see research themes 2 and 4 under **challenge 2**) fall within the scope of **challenge 5**. Biotechnology research centring around the production of advanced fuels falls within the scope of **challenge 2**.

Biorefineries and biosourced building block molecules: Fuel production using bioresources, advanced fuels and/or building block molecules for the chemical industry falls within the scope of research theme 4 of **challenge 2**. On the other hand, research on the manufacture of commodity products or products that are functionalised using biosourced building block molecules or on the upstream elements of plant chemistry sectors (fine chemicals, specialised chemicals) falls within the scope of **challenge 3**.

Carbon use: Research whose aim is to use carbon to generate synthetic fuels or building block molecules for chemical applications falls within the scope of **challenge 2**.

Building and transportation energy efficiency: Research on the integration into buildings or transportation systems of energy components and systems (electrochemical batteries, heat pumps and the like), rather than on the design and manufacture of these components (which fall within the scope of **challenge 2**) are likewise to be submitted under **challenge 6**. New types of combustion, the use of new fuels (including bio-fuels), and depollution systems that mainly centre around transport applications fall within the scope of **challenge 6**.

Smart grids: Projects pertaining to intelligent energy grids fall within the scope of **challenge 2** and not challenge 7, insofar as informatics (e.g. computer algorithms), big data and/or telecom data management techniques (communication protocols) are not the main focus of such projects.

Protection of energy grids and infrastructures: Research on the physical and digital protection of energy grids and infrastructures falls within the scope of **challenge 9**.

Gas sensors: The design and development of gas sensors fall within the scope of **challenge 1** (environmental metrology), **challenge 3** (industrial metrology) or **challenge 9** (explosives; sources of chemical threats).

LEDs and OLEDs: The design and manufacture of LEDs and OLEDs fall within the scope of **challenge 3**, and for electronic applications, **challenge 7**.

Introduction

This challenge will enable the French National Research Agency to bring to bear the top notch scientific and technological expertise necessary to meet the challenges of the energy transition at the national level, within the context of “Factor 4,” by 2050, and for the entire world. The following main objectives come into play here:

- Promoting the **systemic, integrated and multi-disciplinary** approaches that are often needed to address energy challenges.
- Bring to bear, to a greater extent, all scientific disciplines that can generate the **basic** knowledge needed for this energy transition, in the following fields: material sciences (physics and chemistry); engineering sciences (e.g. mechanical and process engineering); earth sciences; life sciences; mathematics; information and communication sciences; the humanities and social sciences. These upstream research endeavours should ideally feed into the thematic challenges described under the challenge’s research themes.
- Promote the emergence and **exploration** of radically new ideas and **concepts that break new ground**: research theme 1 revolves around this type of research.
- Design **materials, methods and processes** that can be used for energy technologies. Here, we would like to fund a broad spectrum of research on **energy related materials**, as follows: from research on and the design of materials exhibiting properties that are useful for the target applications (electronic conduction, photonic conversion, barriers...) up to and including their incorporation into functional systems. Such projects need to fall within the scope of the challenge’s various research themes, depending on the applications in question.
- Carry out **technological proofs of concept**, which can range from the development of experimental laboratory methods or integration of such methods into existing experimental sites. The operational scope of this challenge is nonetheless limited to relatively upstream levels (Technology Readiness Levels 1 through 5), in conjunction with other sources of R&D funding located at more downstream national levels (e.g. ADEME, BPIFrance) and downstream European levels (Horizon 2020). However, we do encourage owners of this type of project – even if the project centres around upstream research phases – to consider the following issues as constraints for the research: usage conditions and constraints; life expectancies; cutbacks; and the search for substitutes for rare or toxic raw materials.

Apart from research theme 1 (which revolves around potentially ground-breaking concepts) and research theme 7 (which directly questions the humanities and social sciences), the other research themes pertain to energy challenges ranging from obtaining primary raw materials to end use, including inter-conversion between energy vectors, storage and distribution.

Research theme 1: Exploration of ground-breaking concepts

This research theme is cross-cutting relative to the other themes. Taking its cue from other agencies’ programmes (e.g. the DOE’s ARPA-E programme, the NSF’s EFRI programme, the JST’s A-STEP High Risk programme in Japan, and Horizon 2020’s Future Emerging Technologies (FET) programme), it aims to set the stage for ground-breaking projects that explore radically new ideas or approaches, and concepts that are radically different from more incremental research that stems from a more conventional approach to science. These breakthrough concepts may fall within the scope of development in previously identified domains (for example, the use of perovskites for solar panels constituted such a breakthrough in 2012), or may result in the creation of a new research field (e.g. approaches that mimic photosynthesis for the production of solar fuels, a decade ago). The task here is to realise a proof of concept concerning the potential of a new idea for an energy application. To this end, this research theme also aims to attract new communities to energy challenges and to promote the creation of new partnerships.

Basic research does not fall solely within the scope of this research theme and ideally should fall within the scope of a research theme other than research theme 1, if such research aims to generate new knowledge in existing sectors or scientific domains. Proposals falling within the scope of research theme 1 will need to demonstrate why they do not fall within the scope of more conventional domains or concepts, and in doing so will need to position themselves vis-à-vis the scientific literature.

Research theme 2: Capture of renewable energy and energy harvesting

Solar energy

During just one hour, the sun radiates a quantity of energy onto the Earth equivalent to the world's entire annual consumption. Only 0.1 percent of this solar energy is used by photosynthesis for biomass production, and only a tiny fraction is used by human beings. The following three paths for transforming this resource into energy vectors come into play and need to be developed:

- Direct generation of electricity via the **photo-electric** effect. The most promising areas of advancement in this domain relate to (a) the use of inorganic, organic or hybrid semiconductors, possibly combined with multi-junctions; and (b) solar concentration and high-yield concepts. The module production technologies also come into play here:

- Heat production, low or high temperatures (**thermal solar** and **concentrated thermodynamic solar** respectively) that can be used for direct heating, as well as to produce cold, electricity and hydrogen, by splitting water using thermochemical cycles.

- **Fuel** production, either (a) via natural **photosynthesis** in order to make biomass for energy applications, the goal being to gain a better understanding of, and improve, the energy yields of certain micro-organisms (e.g. for lipid, sugar and hydrogen production) or (b) via bio-inspired **photo-electrolysis** of water (hydrogen production) or photo-catalysis of carbon (**solar fuel** production).

Other renewable resources (air and water) and energy harvesting

Natural phenomenon (wind, sea waves...) and certain human activities (like free heat) produce other energy resources whose exploitation could allow for diversification and rounding out of the energy mix, or for the generation of energy: air flow, hydraulic flow, heat flow, thermal gradients, pressure gradients, vibration, organic waste and so on. Apart from technologies that are at the demonstration stage, capturing these diffuse resources will require research that lays the groundwork for economically viable innovative technologies in the medium to long term (thermo-electricity, fuel cells, piezo-electricity and so on).

Research theme 3: Use of the subsurface for energy purposes

Although the subsurface produces the lion's share of our current energy resources, it is a compartment that has been under-explored and about which we have insufficient information. Research is needed in this domain, in order to extract key energy resources and to develop underground storage capacities, so that tools, methods and technologies that use the subsurface are competitive, have a relatively small environmental impact and can be incorporated into the energy mix of the future.

Exploration optimisation is a topic that cross-cuts with renewable and non-renewable underground energy resources. **Geothermal energy**, a non-intermittent renewable resource, has tremendous potential for high and low temperature applications in sedimentation basins, as well as in volcanic or magmatic systems. As for **non-renewable** energy (e.g. conventional and unconventional hydrocarbons, gas hydrates, native hydrogen), advances are needed that will pave the way for

economically viable exploitation under environmentally safe conditions both on the surface and underground.

Research is also needed in order to develop the potential for underground **storage of carbon**, as well as for **energy storage** (e.g. heat, hydrogen and compressed air).

We are looking for advances in terms of technical feasibility and the long-term safety and security of extraction and storage methods. This will involve research into on site monitoring and environmental risk management (e.g. surveillance strategies). The development of **methodologies for the evaluation of underground capacities** and characteristics in terms of energy resource extraction and storage will benefit the sector as a whole.

Research theme 4: Carbon-chemistry conversion of primary resources into fuel and building block molecules

Both biosourced and non-biosourced hydrocarbons are bound to play a major role in the energy mix for a long time to come, at a minimum for high density, long-term energy storage, and as a source of carbon for the chemical industry. The task here is to reduce the carbon emissions resulting from the production, transformation and use of these resources.

Thus, in addition to the **direct combustion** of fossil fuel or bio-sourced energy resources (lignocellulosic biomass, organic waste, etc.) to produce heat, electricity or cogeneration of heat and electricity (and which needs to be combined with **carbon capture in stationary sources**), two avenues need to be explored for more efficient production of liquid or gas fuels with low carbon emissions (including biofuels), as well as to provide **biosourced building block molecules** (or **synthons**) that can be used by the chemical industry:

- **Physico-chemical and thermal processes**, the most mature technologies, where avenues for progress revolve around pre-treatment and separation processes, the processing of inorganic components, ash and tar, syngas purification for direct use or fuel conversion, and research on new catalysers to improve process efficiency. In addition, process chain energy integration and optimisation requires particular attention.
- **Biological or biochemical processes** that use micro-organisms and/or enzymes (from selection to development cost management) for purposes of breaking down biomass and converting it into liquid or gas energy components and/or building block molecules. These processes could potentially be combined with physico-chemical methods.

We are also interested in combined conversion and usage pathways for biomass into materials and energy (bio-refinery concept).

The following possibilities need to be explored and developed in this context: the various **carbon transformation and usage pathways**, particularly for captured fossil carbon and for hydrocarbon production, particularly as a way to store intermittent renewable energy and/or provide carbonated molecules for the chemical domain.

Research theme 5: Storage, management and integration into energy grids

Much renewable energy is inherently intermittent and its production is scattershot in nature. We need to be able to guarantee the transport and distribution of renewables via grids under optimal conditions, and develop energy storage solutions that allow for mitigation of the fact that consumption and production tend to be out of sync with each other. Moreover, on-board storage systems need to be developed that reduce dependency on fossil fuels (via electrification of transports for example).

Hydrogen production could potentially be a massive energy storage solution. However, it will have to be produced without carbon emissions (notably using water electrolysis or thermolysis), using

decarbonised energy sources. Moreover, research is needed that will pave the way for the development of **fuel cells** and **hydrogen storage** technologies. For this, upstream research is still needed on materials and structures that will allow for solid storage.

Although certain storage technologies are already mature, in other cases there is considerable room for major advances, for which basic research is still needed in order for solutions to emerge:

- Storage in **electrochemical batteries** for both stationary storage and on-board and mobile applications, will need to improve its energy densities and specific power, as well as its reliability, safety and environmental performance, while at the same bringing down its cost. Storage in **supercapacities** also calls for research into ways to improve safety, as well as energy density.
- **New storage concepts** such as magnetic storage (e.g. SMES), electronic storage, and molecular storage (also see research theme 1 concerning groundbreaking concepts) could also be explored.
- Other types of **storage** are needed for massive electricity storage (compressed air, inertial storage and so on), or for massive heat storage (refractory materials, thermochemistry and so on).

It is also essential that work be done on elements that allow for incorporation into electric grids and the management of electrical energy for both stationary and on-board solutions: **electrical engineering, power electronics and electrical machines** (actuators and generators), whose efficiency hinges on designing and using very high performance materials (e.g. magnetic, dielectric, and electromagnetic materials).

The development of energy sources with optimised spatial and temporal intermittent distribution and storage resources will pave the way for research on **intelligent grids** at various spatial scales, aimed at achieving real time optimisation of the energy system. To this end, we are looking for research in the following areas that draws upon information and communication science:

- managing grids in a manner that integrates space-time predictions of renewable energy production and energy demand; in this regard, issues related to the development of micro-grids (direct current electrical grids in particular), local consumption (including proprietary use) and the design of flexible energy use modes (for industrial processes in particular) that allow for load-shedding or erasure, should be considered. For this, greater insight into usage and consumption is needed.
- As for the dynamics of managing electro-nuclear fleet load aimed at optimally compensating for solar and wind energy intermittence, and limiting the need for storage solutions, this will make it necessary to adapt the nuclear reactor management system and design interruptible heat or hydrogen co-generation modes.
- The reliability and resilience, and the by-design safety of grids.²²
- Management of inter-conversion and interoperability between energy grids (electricity, various gases, heat, etc.),

Apart from the need for purely technical advances for grids and storage, questions also arise that call for a far reaching dialogue with the social sciences and humanities. **Regionally differentiated approaches** to energy and **integrated approaches** to local energy systems and their interdependencies fall within the scope of this type and are encouraged for this challenge. The main tasks here are as follows: optimisation of cost-benefit analyses related to the development of intelligent grids and new services; examining the redefinition of the technological and institutional interface between local and national entities in the establishment of “sustainable regions”; developing analytic methods concerning the role of local resources in the definition of regional policies and integrating their exploitation into the local economic and social fabric; and developing local technical/economic projection tools that are linked to national transition scenarios.

²² Research pertaining to the protection of energy infrastructures and grids falls within the scope of challenge 9.

Research theme 6: Energy efficiency of processes and systems

Considerable energy savings and greater energy use efficiency could be achieved by working directly on the **specific processes**²³ of manufacturing industries (reducing process energy consumption, or doing research into alternative processes that use less energy or have lower carbon emissions) and of energy production (optimisation of conversion yields, loss reduction, energy recovery). Utilities, auxiliary systems and equipment should also be investigated (pumps, heat and cold production systems, ventilation, etc.). This type of research should take into account the environmental constraints (e.g. extreme operating conditions, mechanical constraints, corrosion and dirt build-up minimisation), as well as usage (reliability, robustness, ease of use, rapid ROI). Such research should also be based on modelling and simulation, as well as multi-scale and multi-physical approaches, in order to gain a better understanding of the relevant phenomena and determine the most relevant areas for improvement from the get-go.

When it comes to energy efficiency, it is crucial that work be done on methods and processes for the collection, transport and recovery of waste heat, using either **thermodynamic systems** (heat exchangers, heat pumps, organic Rankine cycles, etc.) or thermo-electric systems.

In addition to seeking greater energy efficiency, the "decarbonisation" of energy should be based on increasing the share of decarbonised electricity generated using industrial processes (e.g. induction or microwave heating), as well as on developing and optimising **combustion** processes with lower greenhouse gas emissions, while integrating **carbon capture and transport** in particular.

Research theme 7: Social science and humanities approaches to the energy transition

The energy transition will come to fruition via combined changes in technologies, behaviours, governance modes, the role of regions, and coordination by markets. In order to promote these changes, it needs to be possible for the relevant initiatives and action plans to be based on an understanding of these changes and their socio-economic impact. To this end, the dialogue between society and the sciences concerning the transition would benefit from being placed in a historical perspective concerning past transitions resulting from innovations or from resource constraints.

Innovation related behaviours, uses and deployment

Shifts in consumer behaviour and lifestyles are key for the energy transition, along with acceptance of the deployment of new technologies. Research is needed into the following: nudges aimed at managing or reducing demand (cognitive psychology, experimental economy); the interplay between consumption modes, flexible user behaviour, and public policy (e.g. ecotaxes, quotas); the impact of the digitalisation of customer-supplier relationships; the citizenry taking on board new energy technologies; the conflicts and stakeholders that come into play in connection with controversial technologies.

Energy transition economy; markets, regulation and governance

Research based on modelling would be useful concerning the following: exploration of new market architectures that would allow for the reconciliation of markets, security of supply, and decarbonisation policies; defining market rules that would make intermittent producers accountable and that would allow for the exploitation of flexibility and storage in electricity markets; improved cross-system integration; market rules at the interface between the central and local levels; macro-economic ramifications; equal access to energy-transition energy; domestic and international industrial strategies; economic and organisational models for sectors.

²³ Only projects whose main objective is to reduce energy use or carbon emissions are eligible under this challenge; projects that address other industrial-process issues fall within the scope of challenge 3.

Long-term modelling

There is room for improvement in the field of long term energy and economy modelling. This could be accomplished by taking the following factors into account: actual behaviour on the part of the relevant stakeholders; technology characteristics; random effects of R&D and industrial development; genuine innovation processes; technical-capital and funding inertia.

D-3) CHALLENGE 3 – INDUSTRIAL RENEWAL

I INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATION

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in [table 1 \(\\$F\)](#). The following countries are particularly relevant for this challenge:

- Germany, Austria, Switzerland
- Canada
- Taiwan, Hong Kong, Singapore, India (engineering sciences).

A complete list of European and international calls for proposals under the generic call for proposals can be found in [table 2 \(\\$F\)](#); the following elements come into play for this challenge:

- ERA-NET M-ERA.NET "Integrated Computational Materials Engineering";
- AAP NSF ANR PIRE programme (Partnerships for International Research and Education);
- ANR-JST (Japan) "From molecular technology to functional materials"

=> These lists are provided for informational purposes only, and are subject to change. Applicants who intend to carry out their projects in a European or international context should regularly visit the French National Research Agency website (<http://www.agence-nationale-recherche.fr/en>) to learn more about these partnerships and calls for proposals.

INTERFACES

This challenge encompasses cross-cutting research areas for other challenges. We indicate below the other challenges that these topic areas fall within the scope of, so as to help applicants select the challenge that is most suitable for their research. Applicants should read the entirety of the challenge documents in question so as to familiarise themselves with their exact attributes.

Big data; biotechnology; sensors; robotics

For information concerning these cross-cutting areas, which by and large fall within the scope of multiple challenges (including challenge 3), see section D "Multi-disciplinarity, cross-cutting and interfaces" in the general introduction to the said section.

Functional materials for energy production and storage (photovoltaic systems, batteries and so on) fall within the scope of **challenge 2** Structural materials for use under extreme conditions fall within the scope of **challenge 3**.

Compounds for energy applications (applications for electrochemistry, energy production and new molecular storage systems) fall within the scope of **challenge 2**.

Biorefineries and biosourced platform compound Fuel production using biosources advanced fuels and/ or building block molecules for the chemical industry falls within the scope of research theme 4 of **challenge 2**. On the other hand, research on (a) the manufacture of commodity products or products that are functionalised using biosourced building block molecules or (b) the upstream elements of plant chemistry sectors (fine chemicals, specialised chemicals) falls within the scope of **challenge 3**.

Exploitation of CO₂ for compound production purposes falls within the scope of **challenge 2**.

Nanotechnologies: Challenge 3 pertains to the generic aspects of nanoparticles, nanomaterials and their assembly in the products of the future. However, ICT applications involving the extensive use of nanoparticles and nanomaterials fall within the scope of research theme 10 of challenge 7, which pertains to technological building blocks for the production and integration of material processes for ICTs. Hence, projects that address around the performance (e.g. sensitivity and selectivity) of physical, chemical and biological sensors for the factories and products of the future fall within the scope of challenge 3, whereas projects pertaining to energy autonomy and the communication capacities of physical sensors fall within the scope of **challenge 7**.

LEDs and OLEDs for low energy consumption lighting fall within the scope of **challenge 3**. The manufacture of basic organic or inorganic electronic devices (including LEDs and OLEDs) falls within the scope of **challenge 7**.

Changes in the world of work at the putative factory of the future fall within the scope of **challenge 3**, whereas more general changes in the world of work falling outside the scope of the industrial sector (precariousness of contracts; employment of senior citizens and migrant workers; mobility of highly skilled workers) fall within the scope of research theme 3 of **challenge 8**.

Bio-economy: Aspects associated with the analysis and design of scenarios related to industrial activities, public policy concerning technology transfers, and regional specialisation strategies all fall within the scope of **challenge 3**. Research on migration to regions containing sectors that use biomass, and the environmental, social, and economic impact of such migration on rural and/or local development and on competitiveness fall within the scope of **challenge 5**.

Introduction

Research funded for this challenge should lay the groundwork for an industrial change that takes into account the constraints of the early 21st century, and in particular environmental constraints: carbon footprints and water, the energy economy, pollution reduction, elimination of toxic substances, the economy of natural resources, recycling etc. France's manufacturers need to (a) shift incrementally to clean and sustainable production; (b) prioritise a circular economy; and (c) beat their competitors to the punch in terms of both goals. The exploitation of human capital, the place in society of industrial firms, production process flexibility, adapting production processes to digital advances, and of course attractiveness and competitiveness are also key factors when it comes to industrial

renewal. The goal of this challenge is to support research that will facilitate these changes in the medium to long term.

This challenge encompasses industrial domains (e.g. manufacturing industries, chemical industries, agro-food industries) and a very broad spectrum of scientific disciplines (physics, chemistry, mechanical engineering, material engineering, industrial engineering, process engineering, work organisation, robotics, etc.). This challenge is consistent with the EU's Horizon 2020 research and innovation programme, and in particular with the *primacy of industry* priority and the *key generic technologies* (KGT) sphere.

The call for proposals aims to fund studies in a broad TRL (Technology Readiness Level) spectrum ranging from basic research (TRL 1) that may eventually lead to practical applications, to research concerning industrial problems (TRL up to 4). We are also looking for (where relevant) analyses of life cycles or even a simplified assessment of life cycles.

The content of the 2015 call for proposals draws upon work carried out in connection with the National Research Strategy, and has the same structure as the 2014 version. However, some changes have been made in an effort to clarify the research themes and achieve greater scientific consistency.

The challenge is structured around five axes. They will also allow for an integrated assessment of the research projects, from the upstream domain to future applications:

Research theme 1: Work; the role of humanity; organisation of ecosystems; social value

Research theme 2: Factory of the future: systems, products, processes

Research theme 3: Materials and process

Research theme 4: Sustainable chemistry and the related products and processes

Research theme 5: Nanomaterials and nanotechnologies for tomorrow's products

Research theme 1: Work; the role of humanity; organisation of ecosystems; social value

It is now a well-established fact that renewal of the industrial sector will require far reaching changes in the context in which the relevant stakeholders evolve. Research on this theme should focus on specific problems that may arise in this context or as a result of these changes, i.e. such problems may be provoked by the changes themselves or may have already existed but are becoming more serious. These problems will become a success factor if they are managed or exploited, and need to be analysed and understood. Hence the domain in question is the factory of the future, as envisaged in connection with various research themes of this challenge. However, the entirety of the ecosystem that needs to exist also enters into the picture, around and between these factories of the future. For in the final analysis, the changes in the requirements, rules and habits of the industrial sector that are necessary for the desired renewal, and the changes induced by this renewal, will have a major impact on the nature and ecosystem of the activity we call "work." These changes need to be facilitated by adapting the frameworks, materials and contracts related to work, and by preparing individuals to succeed in these new frameworks.

Although all future situations cannot possibly be imagined and studied right now, some of them are already perceptible and need to be the subject of research so as to set the stage for all concerned to benefit, i.e. society as a whole, and the persons involved both as individuals and in the context of a business.

There is widespread agreement that the industrial-sector working world of the future will be highly digital (or digitalised) and connected. As a highly automated space, it will also need to be flexible, responsive and adaptable. But at the same time, the "destructuring" of the chain of creation will continue apace.

And finally, we need to bear in mind the positive aspects of today's industrial sector, which make it a cohesive element in our society. Such aspects include the perception of a "shared" adventure, or the existence of solidarity encompassing the entirety of the chain, from creation to realisation. It behoves us to ensure that these elements remain a reality.

Against this backdrop, we consider the following three topic areas to be priority areas for research.

People as a system element

Although human beings will be less directly involved in production related actions, they are nonetheless bound to be a key element in the production systems of the future. These new roles for human beings – monitoring and anticipating; high level management; system reconfiguration; taking action in an emergency – involve their being placed directly in the active process (with its needs for reliability and punctuality), or their being needed solely to intervene in an emergency (perception of a given situation and responding rapidly to it). These new roles will also require new training and qualities, as well as the adaptation of jobs so that responses and decisions are optimal for the efficiency of the processes that human beings interact with. All MMIs in an over-observed environment at the heart of a complex system should provide operators who are responsible for taking an action or making a decision with information that is not only extensive, but also relevant, understandable, and perceptible – so as to help the operator move from the information to a decision. .

New production chain work organisations

Networked businesses, subcontracting and joint activity are terms and situations that are evolving and will continue to do so. New and atypical work organisations will also be facilitated by new information technologies. These changes entail both risks and opportunities. We need to find a harmonious combination of changes in legal frameworks and new technical possibilities, so as to create the necessary solidarity in these disparate organisations and enable this solidarity to coexist with responsibilities and interests that will need to retain a high level of personalisation.

Value and meaning of work

New technologies have already promoted the development of new ways of defining work, as well as a more individualistic approach to work in business settings. How can harmonious coexistence be achieved for the dynamics of change, the appeal of individualised career management, and the collective dimension of industrial sector work, which is one of the elements of cohesiveness in production organisations? This is a key challenge when it comes to successful renewal of the industrial sector.

Research theme 2: Factory of the future: systems, products, processes

This research theme concerns the factory of the future in the broadest sense of the term, in its capacity as a system encompassing the following: from the most upstream supplier to the end customer, the "technological, human resource and organisational" components," for the entirety of the product life cycle. This system, which centres around the human dimension and is supported by digital possibilities, needs to meet the expectations of customers, investors and society as a whole. Such a system needs to supply products that meet market needs, by virtue of a production system that meets the most exacting performance standards and in which the work sphere (arduousness, ergonomics, safety, skills, management, cooperation etc.) is essential. We are looking for projects that fit into one of the five themes described below, and that factor in not only the industrial dimensions, but also more upstream problems. We are particularly interested in projects that break new ground.

The factory system

The factory system, in its “extended enterprise” incarnation, is a complex system comprising various internal components (technologies, human resources, organisations) that call for a systems engineering approach. The design methods here need to integrate interactions between these components themselves and between the components and the environment (the customer, and more generally, society as a whole). For example, designs need to take product life cycles into account, based on circular organisation of the production system. These new design methods need to factor in the related services that will radically transform consumption habits. Production systems designed in this manner will need to factor in society’s new expectations in terms of sustainable development and installation safety, and will need to be suitable for incorporation into local, regional and world-wide ecosystems.

Virtual factories

As from the design stage, a virtual factory needs to allow for the anticipation of changes in technologies, productions and organisations, so as to achieve the best possible industrial performance. Such factories need to be based on digital models of socio-technical systems or organisations. Such models need to be reliable and to allow for performance measurement. Innovative technologies for interactions between people and virtual factories need to allow for the validation of new usage scenarios. It will be necessary to manage complex virtual reality and expanded reality solutions, innovative simulation and product-process optimisation methods, man-robot collaboration simulation techniques, and production reconfiguration mechanisms that allow for the production of high performance designs right off the bat. These virtual factories will also need to allow for more rapid and efficient training of factory personnel acting in a connected environment.

Intelligent, connected and managed factories

Tomorrow’s factories will be intelligent and connected. They will therefore need to integrate new technologies that allow for expansion of the cognitive possibilities of human resources (augmented human beings). Knowledge management will be a key success factor here. Thanks to the Internet of objects, physical objects will become a genuine actor in the factory management process, whereby gathering information as close to the basic product or process as possible and big data processing systems will need to contribute to factory management decisions. The management process, which will need to promote reliable functionality and outstanding responsiveness, will relate to various decision making levels, time frames and scopes (internal and logistics chain). And finally, as with all systems, cyber-security will be a key aspect that will need to be incorporated into the design.

Flexible and agile factories

Increasingly exacting and personalised consumer demand is prompting companies to supply increasingly complex individualised products in an economic and competitive fashion, for both mass and niche markets. Because of increasingly overlapping product portfolio revamping, production system reconfiguration solutions are needed that optimally recycle existing means of production using both plug and play and industrial-organisation approaches. This agility needs to be factored in right from the design phase. These requirements, along with growing product complexity, also means that : the place and role of human beings in the factory need to be revisited; interactions with operators need to be taken into consideration; and thought needs to be given to changes in workers’ skills so that they can better adapt to these ceaseless changes.

Factories based on innovative production processes and resources

In the factories of tomorrow, all dimensions of added value will need to be managed, particularly in the technological sphere. In terms of new criteria for society’s acceptance of factories, we will need innovative production, assembly and commissioning technologies that allow for substantial added

value for the manufacture of highly differentiated products that are also personalised (as with additive manufacturing, for example). Here, the use of new materials transformed using groundbreaking processes will become essential. Design methods will need to be reviewed so as to take these new technologies into account. Implementation of these technologies will require extensive collaboration between people and advanced robotic solutions, whose coordination needs to be thought through in accordance with all dimensions of performance. To this end, it will be necessary to draw upon advanced command and control technologies (cobotics, exoskeletons).

Research theme 3: Materials and processes

When it comes to industrial renewal, materials (metallic materials, composites, polymers, ceramic materials, hybrid materials and so on) will play a key role, whether this involves resource aspects, performance aspects (in the broadest sense the term), or new functionalities. It is essential to associate elaboration, shaping and other processes with these elements in order to support the roll-out of new materials and implement processes that are cleaner, more economical and so on. Generally speaking, metallurgy (e.g. processes, underpinnings, thermodynamics), as well as studies concerning on-line monitoring (e.g. instrumentation and measurement) of these processes should be funded.

This research theme should aim to promote the realisation of projects ranging from the upstream domain to the application phase, while taking into account the following orientations:

Multi-functional and multi-scale multi-materials

As a key element of tomorrow's materials, multi-functionality should be regarded as constituting "customised materials," whereby multiple materials are combined on the basis of a structural and topological organisation that may extend across two or more scales, so as to obtain all of the desired mechanical, thermal, optical and other functions. This can also be accomplished via the direct design of poly-functional materials.

Assembly processes such as riveting, gluing and soldering are likewise multi-material and multi-scale in nature. We are looking for research that addresses the problems related to the heterogeneity of interfacial regions (microstructure gradients, localisation of phenomena under stress), and more particularly the experimentation/modelling approaches and the development of innovative processes.

Material shaping

For material shaping, it is necessary to determine the relationships between the particularities of the materials in question and the processes being used, particularly in modelling tools. Additive manufacturing involving materials (minerals, metallic materials or polymers) also falls within the purview of this research theme.

Biomaterials and bio-inspired materials

We are looking for research on the following: (a) biocompatible materials or the functionalisation of artificial materials for the purpose of regulating/controlling their interactions with living tissue; (b) theoretical and experimental modelling of these interactions; (c) new material manufacturing methods based on processes similar to those used by nature (biomimeticism); and (c) the use of natural materials to regulate and manage the growth of new materials at a reduced energy cost.

New types of chemistry for composite materials

The organic matrices used for structural composite materials are essentially based on thermosetting matrices and require autoclave curing cycles. New chemistries are needed in order to obtain either

(a) materials that can be used outside of the autoclave at polymerisation temperatures ranging from ambient to 100 °C, so as to shorten implementation cycle length and the related costs; or (b) materials that allow for use at high temperatures (up to 300 °C, continuously) and ease of implementation. .

Metallurgical science and engineering

Metallic materials that are used in various industries (e.g. aeronautics, automotive, railroad, construction, and packaging industries) need major changes and breakthrough innovations in both their design and use. The development of innovative alloys is a real challenge in this field. We are looking for proposals that address this need and that could include numerical simulations (ab-initio methods, thermodynamic/kinetic coupling, microstructure history simulations, relationships between microstructures and properties). If extensively combined with experimental approaches that unfold at the same scales as the simulations, these methods could potentially become powerful tools that shorten development times and, when used in combination with classical empirical approaches, endow the industrial sector with a major competitive advantage.

Measurement and instrumentation methods

To improve production quality, it is necessary to also improve process controls. This mainly involves on-line monitoring of material characteristics, which in turn allows operating conditions to be adjusted. In order to obtain data in real time, the development of on-line (and thus real-time) characterisation is essential.

Substitutes for the scarcity of strategic materials and recycling processes

Here, we are looking for proposals concerning materials and the related processes that will (a) allow for either substitution of materials using elements whose availability will be limited by their scarcity (intrinsic or geostrategic) or that will be soon prohibited; and (b) promote the use of natural and/or renewable intrinsically biodegradable materials whose use is based on innovative and, above all, environmentally friendly processes. The search for innovative processes for extraction or recycling of critical materials also falls within the scope of these goals.

Structural materials for extreme conditions

The goal here is to develop a new generation of materials and synthesis processes that will result in performance reliability and/or greater durability under extreme operating conditions (very high temperatures, severe mechanical constraints, high deformation speeds, highly corrosive environments, and so on). Improved performances can be achieved through the optimisation of composition, micro-structure and nano-structure and composite or architecture structures. We are also looking for research on ageing monitoring via integrated sensors, sensor-based monitoring of other intrinsic material characteristics, and self-repairing capacities.

Materials with controlled porosity

The porosity of a given material can be used to regulate intra-material fluid transport or as a structuring element of the material that allows it to be endowed with specific macroscopic properties such as mechanical, acoustic, and optical properties. A broad range of processes and phenomena is available that allow for the generation of controlled porosity on various scales and that could lead to novel applications. These are the breakthrough and innovative actions that we are seeking for this research theme.

Surfaces and interfaces: functionalisation and surface treatment

Solid material usually provides one main function such as a structural function, but is able to interact with the environment by virtue of its surface. Surface treatments or thin coatings aim to endow the

material in question with new characteristics or functionalities. Many different techniques are used for this, and they can also be combined. We are looking for projects aimed at developing innovative approaches in this domain, either via the functionalisation, or by the process(es) used.

Virtual digital material

Among the aims of creating a virtual material are (a) rapid determination of the impact of textures or microstructures on material properties; (b) the impact of microscopic defects on macroscopic behaviour; (c) predicting when a material will no longer be usable; (d) part certification. This process expedites material studies, but its reliability hinges on the capacity of the supporting digital model to represent the structure, behaviour or phenomena under study. We are seeking here not studies on material behaviour via simulations using commercial software, but rather breakthrough modelling solutions that factor in the complexity of a real-world material.

Research theme 4: Sustainable chemistry and the related products and processes

The chemical industry needs to meet challenges in the realm of sustainable development and needs to make human beings a central priority. To do this, the industry needs to change its practices more quickly so as to reduce its use of raw materials, its energy costs and its environmental impact. Such a change mainly hinges on the diversification of raw materials. In this context, the growing importance of plant chemistry is a key response element, which needs to be accompanied by improved resource management, the search for alternative raw materials (activation of CO₂ and of C₁-C₃ molecules), and the development of waste recycling processes. This shift of the chemical industry toward a “circular” economy needs to be rooted in efforts to carry out groundbreaking chemical and process research. Analysis and green design of life cycles needs to be fully integrated at all levels.

In this context, this research theme concerns the development and implementation of new synthesis pathways that use less raw materials and energy. Hence such research can pertain to any aspect of the value chain, from raw materials selection to chemical reactions optimisation (including new reactivities, catalytic objects, “green” solvents) to the related processes incorporating separating or extraction methodologies. Also sought for this research theme is the development of safer and more eco-friendly processes, based above all on process intensification solutions (eco-efficient processes). Finally, applications concerning all chemical sectors, including pharmaceutical chemistry, are also expected.

In the interest of taking into account the environmental and social concerns defined by the National Research Strategy, the following topic areas should be prioritised:

Catalytic systems

Catalysis is indispensable for sustainable chemistry and will be one of the main challenges facing the chemical industry in the coming years. We are looking for innovations involving the following:

- (i) All types of catalysis, namely: heterogeneous catalysts, organo-metallic catalysis, organo-catalysis, bio-catalysis, dual catalysis (combination of two chemical catalyses), and hybrid catalysis (combination of bio-catalysis and chemical catalysis).
- (ii) The design and implementation of nano-catalysts or formulations of catalytic complexes that are innovative and provide improved performance.
- (iii) Metallo-enzymes synthesis and implementation

In the interest of facilitating the emergence of such innovations, we will look most favourably on an approach based on a rational concept for catalysts (e.g. relationships between structure and activity; bio-inspired approaches).

New media, advanced characterisations

In order to achieve eco-friendly chemistry and the related processes, it will probably be necessary to replace classic reaction media with unconventional media such as supercritical CO₂, subcritical water, ionic liquids, eutectic solvents or colloidal mixtures. Such substitutions usually involve preliminary work that allows for efficient implementation of the relevant media, analyses of their life cycles and recycling, their separation, and studies combining theoretical considerations and hands-on experience, so as to take into account the specific reactivities obtained in these media.

Supra-molecular chemistry and molecular assemblies

Molecular assemblies based on weak links play a key role in living organisms (e.g. molecular recognition, molecular receptors, enzyme-substrate interactions) and for the design of intelligent materials. This research theme encompasses areas such as the following in particular: the synthesis of objects endowed with self-assembling or self-organising properties; study of the relevant architectures and assemblies and of reversible or programmable molecular systems; the chemistry of structure-property relationships from both a theoretical and applied standpoint; colloidal chemistry; enzymatic chemistry.

Polymers and macromolecules of natural origin

This area relates to elements such as synthesis pathways and the related processes, functionality management, composite formation, and recycling of natural or synthetic polymers.

Biosourced molecules chemistry

The task here is to investigate the chemical transformation of building block molecules (synthons) into molecules with high added values. The synthons are biosourced and stem from industrial biotechnology facilities such as bio-refineries.

Intensified economic processes

This technological building block involves the development and optimization of innovative processes, based on any of the following: multi-stage synthesis; miniaturisation; microfluidics; transfer linkage; activation methods (e.g. microwaves, ultrasound, photochemistry, electrochemistry); advanced simulations; analysis or control processes.

Bio-inspired chemistry

This component involves the optimisation and/or development of new bio-processes or metabolic recations that pave the way for groundbreaking products or for the synthesis of pharmaceutical compounds. Applied research also comes into play here, particularly in the industrial realm for bio-sensors or bio-remediation.

Proposed research for this theme may possess an experimental, theoretical, technological or industrial character, whereby a multi-disciplinary approach would be privileged. Such proposals can be based on experimental tools (for preparation, advanced characterization, and evaluation of physico-chemical and toxicological properties), or on simulation tools from the molecular to the process scale.

Research theme 5: Nanomaterials and nanotechnologies for tomorrow's products

The factories of the future will be partly based on multi-material and multi-functional technologies and on integrated measurement and detection systems. The performance of these elements will be determined by the extent to which the integration of their functions on the micro or macro scale and

their assembly are designed with the nanometric scale in mind. This scale is rarely used in today's industrial processes. Tomorrow's factories will need technological and scientific chains of building blocks that allow for the development of these materials and sensors.

This challenge is seeking projects that focus on scientific and technological barriers, and whose proposals define the position of the obstacles in question in the knowledge and value chain. These obstacles should be generic in nature. More applied research proposals should be submitted under the ad hoc challenge. For example, the realisation of OPV solutions falls under challenge 2. Similarly, for healthcare related proposals submitted under challenge 3, the identified barrier should relate to (a) its own nanometric configuration; or (b) improving the biological performance provided by this configuration; or (c) the related image processing.

The obstacles have been classified into three groups that correspond to the priorities mandated by the National Research Strategy.

Object production; management of object properties and assemblies

The first technological building block for tomorrow's products is the control of nanomaterial synthesis (nanoparticles, nanowires, nanotubes etc.), which can be hybrids, composites, innovative materials and substrates for flexible opto-electronics (e.g. for lighting) – and using, if possible, the principles of eco-concept and of safe by design objects. The second necessary technological building block pertains to nanometric surface functionalisation, including thin films and nano-object modification that allows for example, for the formation of functional core shells. The capacity to assemble or induce auto-assembly in such nano-objects constitutes a challenge, in terms of obtaining functional bi-dimensional or tri-dimensional materials. Proposals in this domain should focus on assembly reversibility. The development of nano-structuring realisation processes (e.g. electrospinning, coatings, microfluidics, nanofluidics) is another identified element related to achieving the capacity to make new products, and can thus be submitted under this research theme.

Medical applications of nano-objects

The nanometric domain can potentially be the source of groundbreaking biotechnology applications. Proposals in this domain should pertain to the formation and use of nano-objects for medical imagery and the functionalization, the encapsulation and manufacture of nano-objects for medical applications. However, when it comes to this second group, proposals regarding products against cancer, HIV, and hepatitis A cannot be submitted under this challenge, because these themes fall within the scope of Inca and the ANRS.

Sensors and instrumentation

The manufacture of sensors for tomorrow's factories or as future products is a National Strategy of Research priority. Projects falling under this research theme should focus on physical, chemical and biological nano-detectors, as well as on actuators based on the same phenomena. That said, this research area should particularly concentrate on detection performance or on the actions realised by one or some nano-objects. In addition, when it comes instrumentation, the projects here could also centre around the needs of metrology and the characterisation of nano-objects.

One goal of this research theme is to promote the strengthening of ties between enterprise and academic research facilities that could potentially result in technological transfers. Hence the projects here can be experimental, theoretical, technological, industrial, or instrumental in nature, and can include knowledge-acquisition components. From a general standpoint, modelling and simulation aspects can be integrated into projects that comply with all of the barriers defined above, or that form the subject of specific projects. Projects on topic areas from the European FET Flagship Graphene initiative should focus on elucidating the envisaged level of integration. In addition,

projects that exhibit synergy with this initiative but that will be carried out by teams from multiple countries can be submitted under the transnational call for proposals known as Flag-ERA.

The Challenge-Competition instrument as it relates to the challenge

The challenge competition funding instrument is described in section E.1. A challenge competition will be initiated in connection with this challenge, and will be subject to specific call for proposal procedures. For further information, see the timeline of calls for proposals on the French National Research Agency website.

RoMI challenge competition (robots and intelligent machines)

This challenge competition is related to **challenge 7**. As part of the *Plan Robotique de la Nouvelle France Industrielle* (Robotics plan for the new industrial France), scientific and technical barriers that are common to the robotisation of multiple stages of industrial process were identified by major manufacturers. The purpose of this challenge competition is to contribute to the elimination of these barriers.

D-4) CHALLENGE 4 - LIFE, HEALTH AND WELL-BEING

I INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATION

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in [table 1 \(§F\)](#). The following countries are particularly relevant for this challenge:

- Germany, Austria, Switzerland
- Taiwan; Hong Kong; India (neurosciences)
- Brazil (neurosciences, cardiovascular medicine, metabolism)

A complete list of European and international calls for proposals under the generic call for proposals can be found in [table 2 \(§F\)](#); the following elements come into play for this challenge:

Bilateral or multilateral calls for proposals on specific topics areas and subject to a specific timeline:

- Call for proposals on epigenomics with Germany, Canada and Quebec.
- Franco-American call for proposals on computational neuroscience, in conjunction with *Collaborative Research in Computational Neuroscience* (CRCNS) and the US (NS, NIH) and in connection with challenge 7.
- Call for proposals with Japan titled *Molecular technologies for functionalised materials*.

ERA-NETs incorporated into the European programmes of the 7th PCRD or Horizon 2020:

- EuroNanoMed II – Nanomedicine; • EraCoSYsMed - Systems medicine; • Neuron II, neurosciences;
- Flag Era (in conjunction with the Human Brain Project); • Infect-ERA, infectious human diseases; • ANIHWA – animal health and well-being in conjunction with the research themes of challenge 5; • E-Rares 3, rare diseases.

Joint programming initiatives

- JPI AMR, resistance to anti-microbials; • JPND, joint programming on neurodegenerative diseases; • JPI HDHL, Healthy Diet Healthy Life, in conjunction with challenge 5.

=> These lists are provided for informational purposes only, and are subject to change. Applicants who intend to carry out their projects in a European or international context should regularly visit the French National Research Agency website (<http://www.agence-nationale-recherche.fr/en>) to learn more about these partnerships and calls for proposals.

INTERFACES

This challenge encompasses cross-cutting research areas of other challenges. We indicate below the other challenges where these topic areas can be also retrieved, so as to help applicants to select the challenge that is most suitable for their research. Therefore, applicants are strongly encouraged to read the challenges in question before making the selection of the most appropriate challenge and theme for their research project.

Big data; biology; biotechnology; health and environment; sensors; robotics

For information concerning these cross-cutting areas, which by and large fall within the scope of multiple challenges (including challenge 4), see [§ D](#) “Multi-disciplinarity, cross-cutting and interfaces” in the general introduction to the section D.

The aspects concerning **Public health** constitute a robust interface with **challenge 8** and will benefit from common peer reviewers. The medical or epidemiological approach to **healthcare inequalities** fall within the scope of **challenge 4**, whereas their sociological or economic analyses (access to healthcare, health insurance, vulnerabilities, determinants related to social capital, healthcare, and inter-generational relationships) fall within the scope of **challenge 8**.

The CBRN threat and crisis management Research on CBRN threats (Chemical, Biological, Radiological and Nuclear threats) or crisis management (as a result of these threats or environmental risks) in the operational, logistical, economic or other spheres fall within the scope of **challenge 9**.

Overlaps between the various research themes: If your project falls within the scope of multiple research themes, you should apply under the most specific theme available; for example: for antibiotic resistance, apply under “emerging pathologies and resistances”; for synaptic plasticity projects, apply under neurosciences, for lymphocyte related projects apply under defence of the organism etc.

Introduction

The *Life, health and well-being* challenge covers a wide area of research, and intends to address the natural aspiration of citizens to benefit to well-being in the context of optimal healthcare policies. This challenge will allow advancing the frontiers of knowledge through basic research, in conjunction with human health- related activities. Life and health sciences are constantly evolving with new concepts and cross-disciplinary approaches, while new scientific, technological, health and socio-economic challenges develop. Today, the unprecedented progress in multi-scale data and analysis emanating from the observation of the functions of living organisms as well as from the combination of multidisciplinary approaches is benefiting human health. The approaches and concepts of biology now rely on engineering, physics, chemistry, biomaterials, mathematics, informatics, economics and the social sciences and humanities, and in return contribute to these disciplines by fostering the development of bio-inspired technologies. This particularly broad field of biomedical research needs to take into account a context that is particularly affected by the growing ageing population and by the changes in living environments and social behaviour that can promote the advent of pathologies such as damage to the nervous system, metabolic or nutritional disorders or infectious diseases – all of which require nation-wide healthcare measures.

Life, health and well-being is thus a challenge full of potential at the frontiers of knowledge and its transfer to individuals and society. This challenge is also a vehicle for innovation and economic growth through biotechnology, pharmaceutical, diagnostics, and medical devices industries.

The French National Research Agency's funding initiatives aim to complement activities carried out by other funding agencies. For example, the ANR is not intended to fund academic consortia on cancer or HIV/AIDS and viral hepatitis, as these fields are funded by the Inca and the ANRS, respectively. Nevertheless, projects in these domains carried out in partnership with the private sector (PRCE) may nevertheless be funded by ANR. Moreover, these thematic can appear as fundable in specialized separated calls such as Era-Nets. Similarly, projects involving clinical research within the scope of the thematic calls issued by the Institut de Recherche en Santé Publique IRESP or the hospital clinical research programme *Programme Hospitalier de Recherche Clinique* (PHRC) will not be considered by the ANR, while research projects on healthcare systems and healthcare efficiency *per se* should be submitted to the programme known as *Programme de Recherche sur la Performance du système des Soins* (PREPS) run by the Direction générale de l'offre de soins (DGOS).

The life, health and well-being challenge is based on the following three approaches:

- (i) The first aims to gain insight into the multi-scale mechanisms involved in cell biology, physiology, development and ageing processes occurring in living world – this being an essential stage in understanding and diagnosing the pathologies stemming from the dysfunctionality of these mechanisms. The approaches adopted should go beyond the descriptive stage of observation and sequencing of genomes and should seek an intimate knowledge of functional mechanisms bearing promises for innovation the field of human healthcare.
- (ii) The second aims to achieve greater knowledge of pathological processes, eventually leading to risk reduction both at individual and community levels, or fostering compensatory strategies. This approach also encompasses the innovative biomedical approaches such as new biomarkers or cellular-, tissular-, or organism- imaging; new therapeutic targets and compounds; innovative high speed and high content screening methods; pharmacological and galenic innovations; regenerative medicine and replacement biotherapies; biomaterials; technological research in the fields of e-health and telemedicine.
- (iii) The third pillar relates to public health and social sciences around health and healthcare. Particularly targeted are the causality of health risks and inequalities among socio-economic, gender, environmental and cultural contexts; the effects of acute or chronic health shocks on individuals, social groups and their environment; the social, economic and political dynamics related to healthcare innovation and the regulation of health- related activities; methodological research in public health, regardless of application domain.

The ANR will encourage the transnational collaboration in specific scientific domains, in connection with the challenge 4, by putting in place specific actions through European initiatives or by means of specific bilateral or multilateral initiatives. For each of these specific thematic topics, national and international actions will be balanced to reach a funding equilibrium. Addressing the issues related to the *Life, health and well-being* challenge; and in order to support emerging cross-cutting fields, ANR's 2015 funding will focus on 13 scientific research theme, most of which are prone for transversal or multi-disciplinary approaches.

Research theme 1: Study of biological systems and their dynamics, interactions and inter-conversions at the molecular level

The aim of this research section is to understand, visualise and quantify the biochemical and physico-chemical mechanisms that enable the interaction of molecular components in their cellular environment. Moreover, this theme intends to support (a) the emergence of new investigation techniques such as approaches to study unique molecules or cells; and (b) the design of new biological systems (synthetic biology). Furthermore, this heading will foster new experimental approaches to influence living organisms with potential applications in the field of medicine or

biotechnology such as pharmaceuticals or diagnostics. This research theme is particularly prone to scientific convergence involving chemistry, physico-chemistry, informatics, genetics, and molecular, cellular or structural biology and imaging – the goal being to decode and predict macromolecular or complex biological architectures, the dynamics of their interactions and reactivity within cellular or sub-cellular systems.

International initiatives: Some ERA-NET Synbio (synthetic biology) projects could fall within the scope of this research theme.

Research theme 2: Decoding basic biological functions and their integration

This theme aims to shed light on how procaryotic or eukaryotic (all clades included) cells are formed from molecular assemblies, how they grow, multiply, differentiate, enter senescence and are eliminated or replaced, move in response to environmental stimuli, how they interact together to form a multi-cellular organism, tissue, or an organ, and how these mechanisms were settled during evolution. The emergence of new study models will be funded – particularly models with short life-cycle enabling handling in the laboratory. This initiative encompasses the study of adult, foetal and embryonic stem cells in all relevant species and models: self-renewal, differentiation, and normal or pathological tissue remodelling.

Research theme 3: Exploration of the normal and pathological functions of systems and organs: physiology, physiopathology, ageing

The aim of this section is to understand the underpinnings of the hierarchical assembly of tissue and organ components, how their interactions generate their properties, and how changes or malfunction in one or more of their components can induce pathologies. These pathologies often stem among other things from intrinsic factors (genetics/epigenetic, ageing...), extrinsic factors (nutrition, microbiota, infections, drugs, environmental contaminants....) or socio-behavioural factors.

This section aims to sustain projects addressing the whole gamut of biological and social determinants particularly (but not exclusively) those in the domain of metabolic pathologies and nutrition.

The environmental toxicology component will favour approaches concerning toxicity paths or networks, system biology, epigenetics, projects that target the vulnerable stages of an individual's life cycle (foetal stage, puberty) or trans-generational effects, various contaminants particularly integrated exposome including low doses, chronicity and mixed contamination, and research around key life trait in populations dynamics. Particular emphasis should be placed on endocrine disruptors.

International initiatives Certain ERA-Net Synbio, ERACoSysMed (systems medicine) and Era-Net E-Rare 3 projects could fall within the scope of this research theme. ERA-Net Infect-ERA and ANIHWA (infectiology and host-pathogen relationships in humans and animals) projects fall within the scope of this research theme.

Research theme 4: Informatics and digital systems; phenotyping; virtual organisms and pathologies; methodological research; computer technologies and statistics that aim to meet the conceptual and technological challenges of healthcare research

This measure pertains to the following:

- Bio-informatics and bio-statistics tools: modelling in the field of biology, preclinical and clinical research, epidemiology that integrate “big data” or high throughput in biology. The following studies are concerned: nosological breakdown of common diseases, understanding their pathophysiology

and the evaluation of medical interventions. This section encompasses the following: extensive gathering of what is often heterogeneous data; processing and interoperability of these massive data; data interpretation; digital simulations; exploitation towards decision-making; data exchange and sharing; safety and ethics of the management of these data. The methodological and models development towards refinement of concept and reality checking with experimental data also falls within the scope of this axis.

- Digital and personalised medicine:, involving the creation of realistic virtual biomedicine using the aforementioned data (in silico anatomic-functional-metabolic simulations), confronting virtual models with data acquired by physical biological and/or medical systems (patients), and combining medical technologies and an understanding of living systems. This initiative also involves the study of social dynamics and ethical issues related to the emergence and dissemination of these biomedical innovations.

International initiatives Certain ERA-Net ERACoSysMed (systems medicine) projects might fall within the scope of this research theme.

Research theme 5: Genetics and genomics: genotype-phenotype relationships; genome-environment interactions; epigenetics

The goal here is to characterise (a) the mechanisms that preserve the integrity of genomes; and (b) the genetic and epigenetic underpinnings of human disease. Studies on variations in genomic regions targeted by epigenetic modifications, the mechanisms that regulate gene expression and the involvement of non-coding RNA and RNA maturation processes – would be undertaken via cutting-edge basic research as well as through studies on human populations and on animal models.

International initiatives The epigenomics call for proposals with Germany and Canada is related to this research theme. Certain E-Rare-3 projects may also be related to this theme.

Research theme 6: Microbiomes and microbiome-host relationships²⁴

The goal here is to (a) identify the various microbial species of normal and pathological flora of various host species; (b) gain insight into the relationships between microbial flora and the host; and (c) evaluate the role played by microbiomes in organism functions, or in the overall medical context of the host. Please note that physiology projects that revolve around nutrition/digestion and non-pathological digestive flora fall within the scope of challenge 5.

International initiatives Certain ERA-Net Infect-ERA (infectious human diseases) projects fall within the scope of this research theme.

Research theme 7: Exploration of the nervous system and its normal and pathological functions

The goal here is to understand the foundations of the hierarchical assembly of thousands of molecular, cellular and tissular components in the nervous system and the sensory organs, how their dynamics and plasticity generate functional properties, how a change or malfunction in one or more components can provoke a pathology, and how this leads to the identification and validation of therapeutic targets. This initiative also aims to support projects addressing all manifestations, biological and societal determinants, and conditions pertaining to the management or treatment of

²⁴ Environmental microbiomes (air, water, soil, food, industrial biotechnology, etc.) fall within the scope of challenges 1 through 5.

mental illness and psychiatry, particularly as regards autism/pervasive development disorders and addictive behaviours.

International initiatives JPND (Joint Programming on Neurodegenerative Diseases) and ERA- Net Neuron II (neurosciences) initiatives fall within the scope of this theme, along with certain projects of the CRCNS initiative (computational neuroscience), and the ERA-Net Flag-Era initiative (Human Brain Project).

Research theme 8: Study of the body defence mechanisms

In the interest of tackling the increasing frequency of inflammatory, allergic and auto-immune disorders, the goal here is to identify susceptibility genes, decode the interactions between genes and the environment, describe the dynamics of intercellular interactions in various tissues and organs, and identify key molecules and processes necessary for the body to adequately function in normal and stress situations.

Research theme 9: Emergence and transmission of pathogens; resistance

The purpose of this action relates to encourage multi-disciplinary research that addresses the social and environmental dimensions of infectious zoonotic diseases, in order to prepare for, prevent and anticipate epidemic risk or pandemics, and combat resistance to anti-infective agents – to the extent that the project is human-focused. Projects should pertain to inter-species transfers, seasonality and periodicity of transmission, detection of new pathogens, behaviour of vertebrate hosts, carriers and pathogens, as well as possible interventions (vaccination, treatment, etc.). This theme concerns research on societal and public health aspects, and on biodiversity, animal carriers, their dissemination in the environment, and research in case of an emergency.

International initiatives Certain ERA-NET ANIHWA projects (animal health and well-being) and JPI-AMR projects (antimicrobial resistance) fall within the scope of this theme.

Research theme 10: Social inequality in healthcare in France: health, prevention, primary care and social services

The goal here is to strengthen trans-disciplinary research and to advance the debate on possible interventions addressing the main causes and manifestations of healthcare related inequality and vulnerability in France. An adequate response from public authorities in this regard will require prior analysis of the relevant social dimensions, behaviours and psychosocial, economic and biological aspects, the goal being to elucidate the effects of certain social determinants of health, or to characterise the scope and nature of phenomena that lie beyond the reach of this analysis. This initiative also includes the development of research on healthcare policies and on the efficiency and equality of healthcare services. This research theme interfaces extensively with challenge 8, theme 2, which will cover the projects addressing social sciences and humanities and societal topics.

Research theme 11: Translational research in health

This incentive for translational research intends to fund research projects that situated downstream the fundamental and cognitive research, but upstream the clinical research supported by the DGOS Clinical Research Hospital Programme (PHRC). The goal here is to support collaborative projects on scientific issues at the interface between basic and clinical research. This translational research theme aims to break down the barriers between the upstream and downstream domains,

particularly around pathophysiology. We are looking for projects whose outcomes will allow for the formulation of new hypotheses that are likely to be tested in clinical research studies. Projects wishing to obtain joint funding from the French National Research Agency and the DGOS in the context of a possible joint action associated to the “Translational Research in Health Programme” (PRTS) should apply under this research theme.

Research theme 12: Medical innovation; nanotechnology, regenerative medicine; innovative treatments and vaccines

This targeted initiative will support finalised biological and biomedical research projects, and will facilitate the transfer of knowledge between industrial and academic partners in the field of health, with the goal of improving French competitiveness in the biomedical sector. This field concerns solely health related innovations, focusing on detection, diagnosis, prognosis, prevention and treatment of diseases, and on industrialisation and production.

International initiatives: the ERA-NET EuroNanoMed II (nanomedicine) projects fall within the scope of this theme.

Research theme 13: Technologies for health

Engineering and digital sciences are powerful tools in the health and autonomy sectors, allowing the improvement of the quality of life and contributing to important medical advances. They contribute to real changes in the healthcare system and for the quality of life through e-Health, and through compensation for disabilities and loss of autonomy. These transformations raise hope and promises, but also concerns about the risks entailed by the convergence of these technologies or their impact on human capacities. This targeted initiative will allow the development of proofs of concept relevant to the industrial and medical spheres, as well as to the transfer of knowledge between industrials and academic partners in the field of health – the goal being to improve French competitiveness in the biomedical and health device sector. Projects pertaining to research tools for industrial development likewise fall within the scope of this theme.

D-5) CHALLENGE 5 – FOOD SECURITY AND DEMOGRAPHIC CHALLENGES

INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATION

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in [table 1 \(\\$F\)](#). The following countries are particularly relevant for this challenge:

- Taiwan; Hong Kong
- Canada; Brazil (marine research)

A complete list of European and international calls for proposals under the generic call for proposals can be found in [table 2 \(\\$F\)](#); the following elements come into play for this challenge:

- ERA-NET Cofasp (sustainable fisheries exploration);
- ERA-NET ANIHWA (animal health and well-being);
- Plant KBBE (yields from cultivated plants and food safety in the face of climate change);
- JPI FACCE ERA-NET COFUND (sustainable agriculture for the production of alimentary and non-alimentary biomasse);
- ERA-NET ARIMNET (agriculture, agro-food and resource management in Mediterranean countries);
- ERANET-MED (renewable energy and water management in Mediterranean countries).

=> These lists are provided for informational purposes only and are subject to change. Applicants who intend to carry out their projects in a European or international context should regularly visit the French National Research Agency website (<http://www.agence-nationale-recherche.fr/en>) to learn more about these partnerships and calls for proposals.

INTERFACES

This challenge encompasses cross-cutting research for other challenges. The other challenges that these topic areas fall within the scope of are indicated below, so that you can select the challenge that is most suitable for your research. Applicants should read the entirety of the challenge documents in question so as to familiarise themselves with their exact attributes.

Big data; biology; biotechnology; health and environment; sensors; robotics

For information concerning these cross-cutting areas, which by and large fall within the scope of multiple challenges (including **challenge 5**), see section D “Multi-disciplinarity, cross-cutting and interfaces” in the general introduction to the said section.

Ecosystems: Projects addressing the functioning of exploited ecosystems, their adaptation, and the development of innovative sustainable production systems fall within the scope of **challenge 5**.

Research addressing non-exploited ecosystems or their interactions with exploited ecosystems, or that revolves around environmental impact and management, falls within the scope of **challenge 1**.

Microbiomes (research theme 5) Projects that revolve around food and its interactions with microbiomes (ranging from food production to the impact of microbiomes on the digestive tract) fall within the scope of **challenge 5**; projects pertaining to human diseases fall within the scope of **challenge 4**.

Biomass and bioresources Multi-use approaches for biomass whose main goal is not specifically energy related (see research themes 2 and 4 under **challenge 2**) fall within the scope of **challenge 5**. Biotechnology research centring on the production of advanced fuels falls within the scope of **challenge 2**.

Bio-economy (research theme 8) Aspects associated with the analysis and design of scenarios related to industrial activities, public policy concerning technology transfers, and regional specialisation strategies all fall within the scope of **challenge 3**. Research on industrial sectors that use biomass, their migration to regions, and the environmental, social, and economic impact of such migration on rural and/or local development and on competitiveness falls within the scope of **challenge 5**.

Logistics chain: Protection against various risks and threats in the logistics supply chain falls within the scope of **challenge 9**.

The French Ministry of Food, Agriculture and Forests (MAAF) is partnering with the French National Research Agency for the generic call for proposals. The MAAF's activities in this regard will pertain to agro-ecology, including the Ecophyto plan, whose objectives are consistent with the challenge 5 issues. The ministry will contribute additional funding that will allow for the support of projects focusing on these challenges in particular.

In addition, a company known as Apisgene will be partnering with the French National Research Agency in connection with its *Efficacité Global de l'Élevage de Ruminants (EGER)* (Global efficiency of ruminant cultivation) programme, which will characterise and describe underlying genetic mechanisms and take account of regional and cultivation system diversity, in order to identify potential areas for improvement in alimentary and reproductive efficiency, healthcare, ruminant health and wellbeing, and the quality of ruminant products. Apisgene will provide funding for such projects, as a public-private partnership

Introduction

The following represent major challenges for the future of civilisation: world-wide population growth in the face of changes in diets; globalisation of food production chains and commodities; resource scarcity; increasingly severe climatic stresses; and environmental concerns, namely due to consequences of agricultural and fisheries practices. Moreover, the growing tendency to use agricultural, forest, and marine products for bio-sourced chemistry and bio-energy is raising questions concerning scientific strategic choices.

The following three priorities come into play here in particular:

- **Innovations in the productive ecosystems to increase their economic, social and environmental performance.** With the objective of increasing food production world-wide in order to feed a growing population, more efficient production is needed, via (a) the development of biological resources that are compatible with global changes and renewed

and optimised uses; and (b) the development of production systems that use less natural resources (fossil fuel, soil, groundwater, rivers etc.), fertilisers, and phytosanitary products – while at the same time fostering economic growth and job creation. The use of biodiversity and rational use of ecosystem services could improve the sustainability and resilience of production systems.

- **Achieve quantitative and qualitative food security.** The goal here is to feed the planet’s populations “sustainably, equitably and in a healthy way.” All aspects of food systems (production, transformation, interchanges, distribution, and consumption) need to change, taking into account at the same time the objectives of sustainability and economic growth. Innovations should integrate new agricultural and aquaculture raw materials and their derivatives, particularly those obtained from biotechnology and circular economy. These changes should make it possible for consumers, municipalities, manufacturers and other stakeholders to consume moderately and more sustainably and reduce waste and loss. Industries and researchers need to invent eco-friendly and leaner and more efficient processes that also allow for the production of safe food.
- **Promoting the development of the bio-economy at the regional level.** Integrated design of biomass production, transformation and use at the regional level in the face of world-wide economic interdependence entails development, exploration and exploitation of both terrestrial and marine biodiversity. This will be used for both food and non-food applications, while at the same taking into account the need for ecological transition world-wide.

Challenge 5 consists of eight research themes concerning (a) the acquisition of basic knowledge in the field of biology, from the gene to the organism per se; and (b) functional ecology approaches for populations and communities at various organisational levels. These studies (c) should also pertain to changes in stakeholder practices, (d) should encompass social sciences, and (e) should be carried out in particular as public-private research partnerships.

These research themes imply systemic approaches, which will entail the development and integration of multi-disciplinary knowledge and data at various organisational levels.

- Research theme 1: animal biology, plant biology, micro-organism biology, and adaptation to environmental change.
- Research theme 2: research and innovations concerning the performance and sustainability of productive ecosystems.
- Research theme 3: agro-ecology and the design of systems, strategies and policies that support innovative trajectories.
- Research theme 4: characterisation and limitation of ecotoxicological impacts associated with various exploitation systems.
- Research theme 5: lean and efficient processes for safe and healthy food.
- Research theme 6: changes in consumers’ behaviour and in businesses practices for sustainable food systems.
- Research theme 7: biotechnology; bio-resource use
- Research theme 8: bio-economy; circular economy; regional integration of both.

These eight research themes constitute a “system”, while at the same providing a continuum from production to consumption and to biomass recycling for various uses.

Research theme 1: Animal biology, plant biology, micro-organism biology, and adaptation to environmental change.

In order to achieve food safety for a growing population, it will be necessary to (a) develop more productive living organisms that are adapted to the anticipated global changes (climate change and extreme conditions); and (b) improve resource transformation efficiency for fertilisers, water and the like. It will also be necessary to take environmental concerns into account (input, pesticide and water use reduction; reduced soil fertility; salinity; the degradation of water resource quality) and develop alternative production models that are both ethical and sustainable (investigations of genetic diversity and their diversity, animal well being, etc.).

Bringing about this improvement in the performance of individual animals will necessitate biochemical, physiological, genomic, genetic and epigenetic approaches involving the following:

- Characterisation of the mechanisms and determinisms that are involved in the **development, growth, reproduction, production, adaptation and plasticity** of animal, plant and microbe species.
- Decoding the positive (symbiosis, beneficial associations etc.) and negative (parasitism, pathogenicity) **mechanisms and determinisms of interaction between organisms**, particularly as regards the environment. Such research should centre around specific associations, as well as the generic mechanisms of these interactions.

Optimisation of agricultural transition processes necessitates the development of species, strains and varieties by using biological knowledge and testing the capacities of these organisms under real conditions, via the following in particular:

- Conducting experiments to determine **whether the knowledge that has been acquired concerning model species is applicable** to exploited living organisms.
- Determining the **adaptation characteristics needed by exploited living organisms in the face of long term global change**, and investigating the natural biodiversity of alternative species, in order to study the determinisms and mechanisms of expression of these adaptive capacities.
- Development of **modern selection tools** incorporating epigenetic effects.
- Optimisation of **methods that will allow changes** in, expression of, and selection of genomes (reproduction, clonal multiplication, polyploidisation, apomixis, GMO etc.) and helping to define their application domains.

Systems biology (up to modelling) and synthetic biology approaches fall within the scope of this research theme.

Carrying out these types of research could necessitate the use of genomic, transcriptomic, proteomic, and metabolomic tools and the like.

This research theme as a whole falls within the scope of a scale continuum comprising the molecular, cellular, organ, individual and systems biology spheres.

Research theme 2: Research and innovation concerning the performance and sustainability of productive ecosystems

Overuse of inputs, phytosanitary products, and antibiotics is a major concern in today's society and public policies (Ecophyto and Eco-antibio plans), which need to institute new productive systems while taking account of their adaptation to global change and increased biotic risks, as well as the impact on their economic, social and environmental performance. These challenges relate to agriculture, livestock breeding, forestry and fisheries, including in southern countries – the goal being

to achieve integrated and sustainable management of production systems (agro-ecology plan, eco-systems approach to fisheries and so on).

Innovation is needed at the production system and regional levels, the goal being to improve efficiency, reduce waste and pollutants (water and soil quality, greenhouse effect, air quality), manage water and soil resource use, make greater use of biodiversity components, manage major cycles (C, N, P, water), and integrate productive systems into landscapes and regions.

Such research should centre around the following areas:

- **Integrated and sustainable management of plant and animal health**, using genetic innovation, with the goal of reducing the health vulnerability of productive systems.
- **Designing and evaluating bio-surveillance**, bio-vigilance, and bio-control strategies that promote integrated pest management.
- **Using biodiversity** (pollinators, ancillaries, soil organisms) in production systems, in order to improve their flexibility and resilience without compromising their economic viability.
- **Integration of productive systems, ecological infrastructures and protected areas** in order to improve sustainability and performance.
- **Integrated management of carbon, nitrogen, phosphorous and water cycles** in agro-ecosystems at all levels, ranging from parcel to landscape, and for diversified production systems.
- **Management and conservation of soil and soil services**, leading to technical, economic, organisational and public policy innovations.

Impact of production on **water resources and on aquatic compartments**, leading to innovations that allow for improved water management in terms of parcels, exploitation and watersheds

Research theme 3: Agro-ecology and the design of systems, strategies and policies that support innovative trajectories

Making ecosystems more sustainable through the use of agro-ecological approaches often necessitates the re-introduction into systems of a form of heterogeneity and greater diversity, whereas today's socio-technical and economic contexts often induce trajectories of extreme simplification and specialisation. The task here is to determine which actions, strategies and policies could promote changes in productive systems.

Hence moving toward greater sustainability means that improvements need to be made in the following:

- **Characterisation of the change processes in systems and practices**, using methods that incorporate biotechnical dimensions, along with social sciences – the goal being to understand the factors that determine the behaviour of the actors and evolutions.
- **Identification of barriers and levers for action, as well as strategies and policies** that will promote agro-ecological transition for both regions and industries.
- **Design of new innovation paths and learning processes for innovators**; evaluating the desired performance levels (profitability; impact on jobs; rural development; environmental performance, etc.).

Research theme 4: Characterisation and limitation of ecotoxicological impacts associated with various exploitation systems

This research should focus on the following in particular:

- Gaining an understanding of the **ecodynamics of contaminants**, particularly phytosanitary products, medical residues, veterinary products, metabolites and transformation products in aquatic compartments, air, soil, and food.
- **The study of ecotoxicological risks** attributable to multiple low or high dose exposures over a lengthy period, as regards and through development of the concept of exposome.
- The development of **diagnostic tools** that combine potential concentrations, bio-availability, and ecotoxicity, including monitoring via bioindicators and biomarkers.
- **Modelling the interactions** of chemical, biological and ecological processes.

Research theme 5: Lean and efficient processes for safe and healthy food with high organoleptic quality

Agro-food companies need to reconcile the economic, social and ecological aspects of food production, without compromising the intrinsic healthy, sensory, nutritional, functional and organoleptic qualities of the products – and this in a context of increasingly competitive markets, trade globalisation, variability in raw materials, price volatility, and rising economic costs attributable to malnutrition of specific populations.

This research should focus on the following in particular:

- **Innovative and competitive technologies:** food quality management; improved food conservation; flexibility of processes that are adapted to raw-material variability; on-line management and control; operational automation or robotisation; biomechanical techniques, to improve performance and reduce the prevalence of MSDs; cost management; tools that facilitate expertise acquisition and knowledge capitalisation.
- **Optimised raw materials and resources:** biodiversity use; reducing loss and consumption of water, energy, raw materials, packaging and the like; eco-design of food and food production processes; life cycle optimisation; by-product use (circular economy).
- **Food chain and food safety:** pathogens; chemical and immunochemical risks (contaminants, neoformation, allergens); risk assessment methods; active, intelligent, eco-friendly and functional packaging that interacts with the user (ICTs, sensors etc.)
- **Foods and diets that meet the needs of specific populations: sensory perception and food preferences, preventive nutrition.** Here, projects will be prioritised that focus on vulnerable populations, namely the elderly, new-borns, infants, and populations subject to economic insecurity. Priority will be given to biological approaches that apply to food, as well as epidemiological approaches (human cohorts).

Interactions between foods, microbiomes and the food chain. The emphasis here will be on mechanisms involving interactions between food and intestinal microbial ecosystems. It is also on projects pertaining to the management of food microbiomes that are associated with the transformation of food, particularly in terms of the qualities conferred on such food – and more generally, the impact of food-introduced microbiomes on intestinal microbiomes.

Research theme 6: Change in consumer behaviour and in business practices for sustainable food systems

Interactions between food supply and demand as well as stakeholders behaviour need to be better understood in order to provide levers of action for efficient food, public and industrial policies that will guarantee food security for populations.

This research should focus on the following in particular:

- **The social, economic and sensory determinants** of choices, preferences, consumption practices and social, cultural and physical activities, aimed at promoting healthier lifestyles. Priority will be given to field experiments.
- **Food access and food systems issues, in the objective of food security:** international trade; food systems and households; households strategies in the face of food insecurity; food and nutritional status of disadvantaged populations Food and dietary transitions: diet and food transitions on the part of populations experiencing income growth and/or migrant populations (rural/urban; north/south; world-wide); economic, social, health and environmental impact of nutritional transitions. **Industrial strategies:** the problems entailed by competition and the synergy of the food industry, agro-industry, and distribution sector; strategies adopted by companies vis-à-vis public policy and regulations.
- **Quantitative and qualitative balance between food supply and demand:** integration, at all the various levels, of the impact of global changes, nutritional transitions, industrial organisations, urbanisation processes, and risks and uncertainties.
- **The social and economic organisation of food systems:** food chain capacity to take on board new qualitative constraints and increase productivity; regional dynamics and organisational structures of food systems; value-added distribution along the food chain; resistance and resilience in the face of economic or sanitary risks.
- **Public policy and food safety and security governance:** policies instruments to modify food behaviours; regional, national and international food safety regulations and norms and measures; conditions to promote of food security policies.

Research theme 7: Biotechnology; bio-resource use

The task here is to develop and optimise food and non-food uses of bio-resources, particularly by instituting biotechnology methods. To meet this challenge, basic biology research will be necessary at various levels, from the gene to the organism as a whole. This research theme encompasses the optimisation of key generic technologies that are based on genomics and post-genomics, as well as synthetic biology and systems biology.

The following types of research come into play here:

- **Investigating continental and marine biodiversity** for the development of bio-resources that are adapted to new climatic, economic and demographic conditions, via approaches from the fields of biochemistry, biology, and genomics in particular.
- **Promoting the emergence of new bio-resources through the development of generic technologies** that are based on genomics and post-genomics, as well as synthetic biology and systems biology (up to modelling).
- **Investigations of the metabolic pathways** of biomolecules of interest, and their regulation; optimisation of these paths and their production levels in experimental systems.
- **Development of various biological engineering pathways** for bio-molecule production by microbial, plant or animal systems.

- **Development of biotechnology** and/or chemical approaches, so as to optimise extraction, refining, fractionation and transformation – the goal being to promote the production and quality of bio-sourced biomass and compounds.

Research in this domain can also relate to all bio-molecules, particularly new dietary proteins plants, as well as bio-molecules for the agro-food industry and all non-food bio-molecules (e.g. bioactive bio-molecules for animal and plant health; bio-sourced materials; building block molecules). The possible fields of investigation here include chemical, biochemical, liquid enzymology, and matrix investigations. The research spectrum ranges from the gene or bio-molecule to the organism as a whole, and from basic biological research to the proof of concept – but in a manner that takes strokes into account in particular.

Research theme 8: Bio-economy; circular economy; regional integration of both

At the regional/national level, integrated systems are needed for production, transformation, refining and consumption at various levels (regional, national, global, north/south). The following are also in need of evaluation for the value chain of sectors that use biomass: (i) environmental impact (carbon, resources, soil, biodiversity); (ii) social impact; (iii) economic impact; (iv) impact on rural and local development (e.g. capture of added value; brief usage cycles); and (v) impact on competitiveness. In parallel with technological innovations, social science research on the integration of industry and biomass applications at various territorial scales are also encouraged.

Research here should focus on the following:

- **The study and design of adjustment and optimisation on the part of available resources and processes**, to facilitate resource assemblies in sector networks at the regional/national level, including activity repurposing to allow for adaptation to global changes, or in the presence of soil contamination.
- **Development of social, environmental and economic performance tools for innovative business models**, value chains and territorial deployment scenarios that provide public policymakers with information on regional impacts and timelines extending over decades or less. These tools should also encompass the challenges related to participation on the part of various regional/national stakeholders in technological choices.
- **Development of decision making and analysis tools** for policymakers, as well as private and public sector strategies (technology transfers, innovation policies, intelligent regional specialisation strategies, production diversification related to the agro-ecological plan)

Mediterranean region

The emphasis here is on research conducted in the Mediterranean region in partnership between European countries and countries on the southern and eastern coast of the Mediterranean. In 2015, this will be accomplished through two specific actions: ERA-NET ARIMNET 2 and ERANET-MED calls for proposals on agriculture and food in the Mediterranean, renewable energy and water management.

D-6) CHALLENGE 6 – SUSTAINABLE MOBILITY AND URBAN SYSTEMS

INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATION

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in [table 1 \(\\$F\)](#). The following countries are particularly relevant for this challenge:

- Germany; Austria; Switzerland;
- Canada;
- Taiwan; Hong Kong; India; (engineering sciences).

=> This list is provided for informational purposes only and is subject to change. Applicants who intend to carry out their projects in a European or international context should regularly visit the French National Research Agency website (<http://www.agence-nationale-recherche.fr/en>) to learn more about these partnerships.

INTERFACES

This challenge encompasses cross-cutting research for other challenges. The other challenges that these topic areas fall within the scope of are indicated below, so that you can select the challenge that is most suitable for your research. Applicants should read the entirety of the challenge documents in question so as to familiarise themselves with their exact attributes.

Big data; robotics

For information concerning these cross-cutting areas, which by and large fall within the scope of multiple challenges (including **challenge 6**), see [§ D](#) “Multi-disciplinarity, cross-cutting and interfaces” in the general introduction to the said section.

Challenges with a preponderant urban dimension: Projects that mainly focus on the specifically urban dimension of a given issue (e.g. urban strategies for adaptation to climate change, urban agriculture) fall within the scope of **challenge 6**. Projects without a specifically urban thrust fall within the scope of the other challenge that the project relates to. Thus, for example, development of an eco-technology that is not specifically urban falls within the scope of challenge 2, even if it will mainly unfold in the urban domain.

Infrastructure safety/security: Research pertaining to critical infrastructure safety or security in the face of identified risks or threats, and/or pertaining to non-urban infrastructures, falls within the scope of **challenge 9**.

Energy: Research on renewable urban energy, batteries, recharging infrastructures, fuel cells, hydrogen storage facilities, low consumption power electronics, and high performance machines falls within the scope of **challenge 2**, subject to the specific performance specifications that apply to transportation applications.

Projects on the integration of such technologies into vehicles fall within the scope of **challenge 6**. New types of combustion and the use of new fuels for transportation of any kind fall within the scope of **challenge 6**, insofar as the question arises as to their use/application for a motorised system.

Smart grids: Technical approaches for smart grids fall within the scope of **challenge 2**, whereas the impact of their use on urban systems and transportation systems fall within the scope of **challenge 6**.

Introduction

This challenge aims to explore the ability of urban systems, built structures and transportation systems to be transformed into elements that are compatible with sustainable development. To accomplish this, it is necessary to achieve a greater understanding of the processes that come into play in the physical, environmental, political and socio-cultural dimensions. Urbanised areas are at the intersection of issues concerning housing, mobility – and more generally, social harmony. Cities, which account for 70 percent of energy consumption in Europe, also greatly contribute to the greenhouse effect and environmental inputs, via the material and energy flows that supply cities. Conversely, they are also sensitive to environmental pollution and the consequences of global change. The other major challenges concern the following: building and transportation performance; the organisation of urban systems promoting easy and efficient access to resources and services; the emergence of the digital society to guide, develop and promote sustainable uses of transportation and manage cities more intelligently (smart cities); and the continuity of infrastructures and grids, and their adaptation to current and emerging needs.

The following scientific objectives come into play in this regard:

- Generating new knowledge on energy efficiency, environmental impacts and quality of use (comfort, air quality, noise, security, etc.) for elements such as vehicles and buildings, and at various levels (e.g. blocks, districts, cities, networks of cities); while at the same studying the interactions between these challenges and scales.
- Develop phenomena modelling for design and decision making support, and for performance assessment.
- Participate in the development of methodological and technological solutions for building and renovating in order to adapt pre-existing elements to new energy, environmental and usage requirements, so as to more efficiently manage the various components of urban and transportation systems in a manner that involves users if necessary.

Research theme 1: Sustainable urban systems

As cities are complex systems, integrated multi-sectorial and cross-disciplinary approaches are necessary in order to better understand the way urban systems evolve, on various temporal and spatial levels.

Socio-spatial approaches to sustainability, mobility, improvements and practices

The **urban dynamics**, transitions and interactions between short and long timescales and between the local and global levels still constitute relatively unknown territory, despite their centrality to achieving sustainability. The task here is to gain a better understanding of the factors that drive urban change (growth, decline, economic and social attractiveness and so on) and that contribute to consolidating or weakening urban systems and to renewing relationships between large urban areas, medium sized cities, and small rural towns – by re-investigating the locations of populations and economic activities (town centres, suburbs, rural areas, etc.). In this regard, it is also important to re-examine the interplay between urban forms, the structure of the urban fabric, the range of available transportation services and infrastructures, mobility, and environmental impact. Ideally, such research should shed light on the controversies concerning densification, compactness and mixes (functional, social or generational), multipolarity, etc. To accomplish this, it is essential that **modelling** be brought to bear.

City-dwellers' habits are gradually changing, especially due to the "environmentalisation" of their representations. Other factors contribute to these transformations, such as the economic crisis and the development of remote services. However, there are still discrepancies and even contradictions between more eco-centred representations and actual practices, which often remain resource-intensive. This holds true for mobility habits, which are related to residential choices, the locations of economic activities and the layouts of transport grids. Knowledge, understanding and management of the social friction inherent in the advent of **sustainable mobility, habitat, and public-space usage practices** and the like constitute a full-fledged research area.

Echoing questions of well-being and quality of life, research on urban sustainability calls for a convergence of studies on the **transformations in urban lifestyles** and the relationships that societies have with their environment. Such research necessitates contributions involving cross-fertilisation on the part of numerous disciplines, namely geography, history, sociology, anthropology, psychology, economics, law, and political science.

Projects that focus specifically on issues related to segregation and inequality fall within the scope of **challenge 8**, even if they adopt spatialised approaches that apply to urban areas.

Quality of the urban environment; ecosystem services; optimal resource use

Cities consume large amounts of materials, food products and energy, some of which is discharged into the water, air and soil in the form of emissions. Hence it is essential to gain a greater understanding of the processes of this **urban metabolism**. The underlying issues centre around understanding and monitoring how cities function, their interactions with the biosphere, and their **environmental inputs** (noise, pollution and the like), but also raise the issues of foresight planning and action: sealing off flows, urban, agricultural and industrial symbioses, relationships between inequality and vulnerability and resilience of neighbourhoods, short circuits, spatial use conflicts, etc. Although we are beginning to understand some of the roles played by **nature in cities**, the generation of new knowledge about how urban socio-ecosystems work is needed in order to lay the groundwork for urban ecological engineering science. These ecosystems provide numerous services, namely supply services, regulation services, and services of a social nature. It is essential to find approaches for ecosystem service assessment, in connection with the issue of soil use (eco-balance, social contribution to adaptation to climate change, etc.).

Urban system vulnerabilities and resilience

In connection with these two themes, the issues of (a) **urban vulnerability** to sudden events (flooding, heat waves, riots, pollution spikes etc.) or to incremental change (gradual impact of climate change, demographic ageing and so on); and (b) **resilience** need to be addressed from a systems standpoint. The task here is to quantify fragility and evaluate the overall vulnerability of urban systems. An important issue, both for knowledge and for operational aims, concerns the development of resilience and adaptation strategies.

In term of environmental risks, forecasting systems, threat assessments, and alert thresholds (e.g. disaster and risk factor characterisation, observational tools and methods) fall within the scope of challenge 1, while crisis management falls within the scope of challenge 9.

Research theme 2: From buildings to sustainable built living environments

From buildings to positive energy and low environmental impact blocks

If, by 2020, all new buildings will have to be energy positive (RT2020) and environmentally “responsible” (RBR2020), research issues remain unresolved as to which spatial and temporal scales are best for addressing this concept – whereby the **block** is an integration scale well worth investigating. That said, the fact remains that the objectives for **improving the energy efficiency of existing buildings** are highly ambitious.

Regulations concerning building energy efficiency replace an obligation of means with an obligation of result. Although this change allows for greater freedom of choice and is likely to promote technical and architectural innovation, it will also require the development of reliable methodologies and instruments for **physical measurements** (particularly for energy audits and performance monitoring). Many **building design tools and models** are based on hypotheses that the new energy performance targets render obsolete, particularly because secondary, hitherto ignored phenomena have now come to the fore. It is important to review these tools intended for design, construction and renovation (digital models). Such tools need to take into account not only energy issues, but also (a) health issues (**indoor air quality** etc.), comfort issues (lighting, acoustics, odours, etc.) via multi-physical approaches; and (b) interactions/feedback between users and technical systems. All this requires better knowledge of behaviours, qualities and usage values and closer cooperation between social sciences/humanities and engineering researchers, the better to anticipate the actual performance of buildings. It is also necessary to design buildings (and the necessary materials) that are more user friendly, that perform well for a broad range of uses, and that take users’ practices into account from the get-go. An important area of research here concerns economic models, as well as the manner in which innovations are disseminated and adopted by stakeholders in the construction industry and by users, particularly in the **renovation** industry.

Civil engineering, construction and management of the architectural heritage and of infrastructures

Apart from solely energy related challenges, keeping the architectural heritage and existing infrastructures intact remains a major challenge in terms of sustainable development. It is first and foremost necessary to gain greater knowledge concerning (a) the ageing mechanisms of materials and infrastructures; (b) performance loss; and (c) the risk that heritage structures may decay. But it is also important to rethink current construction, maintenance and management solutions, the materials to be used, low cost and high performance renovation/re-engineering technologies, the methods used to work on buildings, transportation infrastructures, and grids – while at the same time limiting building downtime and taking into account future scarcity constraints, the potential impact of climate change, and the overall life cycle of the buildings in question.

Research theme 3: Safe and eco-friendly vehicles

Vehicle energy efficiency: power chains and comprehensive approaches

Reducing the environmental impact of motor vehicles mainly hinges on overcoming scientific and technological obstacles to the widespread use of vehicles with a minimal carbon footprint. This evolution needs to be driven by research centring around the following: very high energy efficiency and very low emission **power chains**;²⁵ **depollution systems**; the use of **internal combustion engines** that run on fuel that has lower greenhouse gas emissions than fossil fuels (including bio-fuels²⁶); vehicle **electrification and hybridisation**; **recovery and management of on-board energy**; and **broader approaches** such as **light-weighting** or improving vehicle **aerodynamics**. Research in this regard can focus on anything from improving simulation models and laboratory experiments aimed at overcoming scientific obstacles, to building demonstrators that allow for the study of more technological dimensions of motor vehicles, ships and aircraft.

Safety, security, driver assistance systems, transportation automation, reliability

In the search for ways to reduce the energy impact of mobility, security, it is important that safety and overall efficiency also be borne in mind. These goals can be achieved by (a) developing new types of vehicles that are more in sync with consumer demand, more accessible, and more ergonomic (particularly for handicapped persons); (b) integrating more passive and active safety technologies so as to reduce mortality and insecurity; and (c) developing **driver assistance** systems and systems that allow for communication between vehicles and with infrastructure elements.

In this context, the development of **fully automatic motor vehicles** falls within the scope of improving safety and efficiency. The reliability dimension of on-board vehicle systems, particularly electronic and IT systems, should also be considered. These advances will only have a genuine impact if the expectations and behaviours of drivers/users and vehicle usage constraints are taken into account.

Research theme 4: Efficient grids and services

Transportation networks and services

Apart from research on vehicles per se, it is also necessary to completely rethink transportation systems so as to render them not only more efficient, but also better adapted to the needs and evolutions of urban systems. To do this, it is necessary to draw upon technologies that promote the following: multiple modalities and inter-operability; optimised exploitation of all types of transportation grids; real-time **traffic** management in order to reduce congestion, for both cars and commercial vehicles, and at all spatial levels (urban, rural, inter-urban and so on).

The development of **transportation service portfolios** based on a good understanding of the dynamics of mobility and **logistics** should also aim for this objective.

Resilient urban networks and services in sync with real needs

Cities operate on the basis of shared urban services such as water, sewage and garbage collection that are incorporated into networks. Above and beyond the tools (e.g. inspection, maintenance and repair strategies) necessary to keep these pre-existing networks in good working order, questions arise as to how these services may evolve and the institution of new services that are better adapted

²⁵ Combustion related projects that center around transportation applications fall within the scope of challenge 6, not challenge 2.

²⁶ Fuel production processes fall within the scope of challenge 2, whereas the use of fuel for transportation (yield and pollution) falls within the scope of challenge 6.

to new constraints (e.g. energy saving, budgetary constraints) and emerging needs (e.g. demographic ageing), and that benefit from the development of information and communication technologies. Such research should also contribute to the development of urban engineering innovations aimed at strengthening resilience and capacities for the adaptation (or even reversibility) of constructions and infrastructures to the needs of future generations and to environmental transformations, particularly by adopting design and management approaches that are informed by actual usage practices. The task here is to devise solutions that allow for service continuity, even in degraded mode. Inter-networks synergies that are “tailored” to local conditions, as well as smaller-scale solutions, should also be investigated.

Smart cities; new uses; innovative services

Today’s information and communication technologies tend to be limited to supporting and enhancing the efficiency and productivity of existing services and organisations, without calling into question the actual workings and design of these elements. Such services and organisations should also constitute essential vectors for the development of urban services and the organisation of urban activities such as tele-working that use less energy. Hence we are looking in particular for innovative solutions that combine technologies with new service concepts (realisation, exploitation, economic models, engineering, logistics) and other non-technological activities (e.g. information modes, regulatory aspects, governance, brakes, hidden effects on behaviour). Such information and communication technology contributions to urban production and services should be the subject to multidisciplinary research, as should the impact of the intelligent city on city-dwellers' habits and on urban metabolism

Challenge Competitions as they relate to the challenge

The challenge competition funding instrument is described in section E.1.

A challenge competition will be initiated in connection with this challenge, and will be subject to specific call for proposal procedures. For further information, see the timeline of calls for proposals on the French National Research Agency website.

The **VIVIANES** (Intelligent Vehicles in the City - Independent Navigation and Safety) challenge competition:

At the interface of challenges 6 and 7: Above and beyond driver assistance systems and autonomous navigation functions, automobiles in tomorrow’s urban infrastructures would appear to be a natural evolution. The VIVIANES challenge competition aims to encourage the development of low-cost solutions, which will be evaluated and compared in the course of exacting contests.

D-7) CHALLENGE 7 – INFORMATION AND COMMUNICATION SOCIETY

INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATION

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in [table 1 \(§F\)](#).

A complete list of European and international calls for proposals under the generic call for proposals can be found in [table 2 \(§F\)](#); the following elements come into play for this challenge:

- ERA-NET CHIST-ERA II: *Resilient Trustworthy Cyber-Physical Systems, Human Language Understanding* (Europe);
- ERA-NET FLAG-ERA: *Graphene, Computational Neurosciences* (Europe);
- CRCNS : *Computational neurosciences* (Germany, Israel, USA);
- BDEC: *Application Software towards Big Data and Extreme Computing for Global Scale Issues* (G8 countries);
- SPPEXA: *Software for Exascale Computing* (Germany, Japan).

=> These lists are provided for informational purposes only and are subject to change. Applicants who intend to carry out their projects in a European or international context should regularly visit the French National Research Agency website (<http://www.agence-nationale-recherche.fr/en>) to learn more about these partnerships and calls for proposals.

INTERFACES

This challenge encompasses research topics that are cross-cutting with other challenges. The other challenges that these topic areas fall within the scope of are indicated below, so that you can select the challenge that is most suitable for your research. Applicants should read the entirety of the challenge documents in question so as to familiarise themselves with their exact attributes.

Big data; sensors; robotics

For information concerning these cross-cutting areas, which largely relate to several challenges (including **challenge 7**), the reader is invited to see [§ D](#) “Multi-disciplinarity, cross-cutting and interfaces” in the general introduction to the said section.

Digital society – research themes 1, 2, 3 and challenge 8: Research themes 1, 2, and 3 partly overlap with research themes from challenge 8. The projects which are expected in **challenge 7** can be interdisciplinary, provided that they involve a significant amount of research in or about the digital

sciences. Projects involving a significant amount of humanities and social sciences research and whose digital dimension is limited to the use of state of the art digital tools fall within the scope of **challenge 8**.

Security – research theme 6 and challenge 9 Research theme 6 under **challenge 7** is highly complementary to the *cyber-security of society and the fight against cybercrimes* theme of **challenge 9**. Proposals concerning cryptology, biometry, and the fight against cybercrimes fall within the scope of **challenge 9**. Research concerning anti-fraud measure or malicious use of systems likewise falls within the scope of **challenge 9**.

Smart grids – research themes 5, 6, and 8, and challenge 2: Projects pertaining to intelligent energy grids fall within the scope of **challenge 2** and not challenge 7, insofar as informatics (e.g. computer algorithms), big data and/or telecom data management techniques (communication protocols) are not the main focus of such projects.

Nanotechnologies – research theme 10 and challenge 3: Challenge 7 pertains to technological building blocks for the production and integration of material processes for ICT. **Challenge 3** pertains to the generic aspects of nanoparticles, nanomaterials and their assembly in the products of the future. However, projects pertaining to ICT and extensively involving nanoparticles and nanomaterials fall within the scope of research theme 10 of **challenge 7**.

LEDs and OLEDs for lighting fall within the scope of **challenge 3**. The manufacture of basic organic or inorganic electronic devices (including LEDs and OLEDs) falls within the scope of **challenge 7**.

Introduction

The new information and communication technologies have a profound impact on society. Information, services and applications are available at all times and in all places. New uses and massive data generation are significantly changing our lives and habits. If digital technologies are a driver of scientific and technical excellence, they also represent a societal challenge in three ways: (a) an economic challenge, because digital technology accounts for a substantial portion of European economic growth (5.9 percent of GDP); (b) a challenge to national sovereignty, in the face of the globalisation of data exchanges and the digitalisation of many critical uses; and (c) a challenge to society, because digital technologies are increasingly used as social and cultural platforms.

The *information and communication society* challenge pertains to digital science and technology as assets for society in general, in conjunction with the various digital applications which fall within the scope of the other societal challenges of the 2015 Work Programme. Hence this challenge entails a dual priority: promoting reflexive research on digital sciences and technologies embedded in the *digital society*, and preparing the digital breakthroughs of tomorrow by bringing about advances in concepts, methods and tools. The most important research themes for 2015 are education and training, massive data processing, transforming data into knowledge, decision making support, high-performance computing and digital simulation, interactions between the physical, human and digital worlds, and security in a digital society.

This challenge applies to the whole innovation chain, from the most basic research up to the design and development of pre-production tools and methods.

The challenge comprises ten research themes that fall within the scope of two parts, defined by the ultimate goal of the research:

- Focus on the digital society
- Focus on digital science and technology

The first three research themes, which belong to the *digital society* part, partly overlap with themes of the challenge 8 *innovative, inclusive and adaptive societies*. The projects which are expected can be interdisciplinary, provided that they involve a significant amount of digital-science research.

Research theme 1: Digital sciences and technologies for education and training

There are four main issues for digital sciences and technologies in education and training: technology (e.g. development and deployment of platforms; content management; multimodal interfaces; user behaviour management); methodology (e.g. educational engineering, content design, learning assessment); economics (e.g. cost, return on investment); societal (e.g. the right to access to knowledge, recognition of individual value, scientific and technological intelligence). **Under challenge 7, projects can be supported that address one or more of these challenges, provided that such projects clearly indicate their technological research focus.**

To illustrate (by way of an indicative example) how this research theme complements the “Life-long education and job training” and “Digital revolution and social change” research themes of challenge 8 (Innovative, inclusive and adaptive societies), a project about MOOCs concerning data extraction from the traces of interactions and forums clearly falls within the scope of **challenge 7**, whereas a project that uses such data to define the profile of the audience of MOOCs falls within the scope of **challenge 8**.

Learning design, which requires cross-disciplinary work (including cognitive sciences, social sciences and humanities) to invent and evaluate new forms of knowledge acquisition, should be the lynchpin of research on e-learning. Emphasis should be given to education and training on the use of digital technology, and on computer sciences in particular, starting at an early age, and on developing digital literacy among teachers, in order to better meet the needs for personnel qualified to hold jobs requiring digital technology skills.

Proposals concerning research on new approaches to professional training and life-long learning related to issues raised by all the societal challenges, and in particular challenge 3 (industrial renewal), are welcome.

Research theme 2: The digital milieu: a technology of the intellect and a knowledge medium

This research theme pertains to the changes brought to knowledge itself by the the digital milieu , i.e. the definition of the objects of knowledge, and the formalization and transmission of knowledge. We are expecting research carried out from three points of view, which can be either combined or addressed separately. **The involvement of research teams from digital technologies and sciences in projects submitted under this theme is strongly encouraged.**

Intra-disciplinary or inter-disciplinary epistemological research

The digital technologies bring changes into the praxis of most scientific disciplines, sometimes up to the very constitution of the objects they investigate. This topic aims at fostering theoretical

reflections about these changes which can occur at different levels. Examples range from theoretical computer sciences as a discourse which formalizes the conditions of knowledge, to humanities and social sciences (especially the sciences of the past, no matter whether ancient or recent) called into question by the *digital humanities*.

Practical research

This involves the development of digital research instruments based on a theoretical framework such as the one described above. Such instruments can be applied to one discipline, a cluster of disciplines, or be generic to all scientific disciplines..

Applied research on publication tools and peer debates

Such tools are at the core of the scientific praxis. They can be improved with the edition of the wealth of data which is a byproduct of the digital instruments mentioned above. The academic publishing sector could benefit from this research which invents new methods and new standards.

Research theme 3: Digital technology in the service of the arts, heritage, and the culture and publishing industries

Like theoretical and practical knowledge, art, culture leisure and heritage elements undergo change by virtue of new practices on the part of professionals and the general public related to digital science and technology. These practices foster the emergence of new creative dimensions, new forms of expression, narrative, multimedia writing and transmedia content, based in particular on collaborative creative work, sharing, and on mobile or immersive devices.

We are looking for research that aims to: (a) support the transformation of practices related to heritage elements and the culture and publishing industries; and (b) address new digital content production, distribution, enrichment and consumption practices, together with the related problems of rights of use and exploitation (flagging, traceability). In the technical and scientific information domain, proposals concerning technological platforms fostering new open-access publishing practices are eligible.

This research theme is related to the "Culture and heritage" theme of the "Innovative, inclusive and adaptive societies" challenge.

The research themes described below, which fall within the scope of “digital science and technology,” encompass all research in the digital domain and potentially involve collaboration with other disciplines. For the “Underpinnings of digital technology” research theme, we are looking for basic-research proposals that do not fall within the scope of other themes. For all other themes, we are looking for proposals ranging from basic to finalised research on all matters that fall within the scope of the research theme. We welcome applications on open-resource strategies that promote software longevity and sharing.

Research theme 4: Underpinnings of digital technology

This research theme involves basic research striving for excellence and breakthroughs in informatics, systems and communication science and engineering and mathematics. It is important to strongly encourage basic research, as it is the driver of advances that will give rise to and inform applied research.

Each of the challenge 7 research themes expressly includes basic research on the topic area of this research theme. Following are selected examples:

- Research on formal methods and model engineering falls within the scope of research theme 5 (Software science and technology).

- Research that aims to strengthen the confidence of system users falls within the scope of research theme 6 (Science and technology for digital confidence and security).
- Research on image, word or music processing falls within the scope of research theme 7 (Human-machine interactions, connected objects, digital content, big data, and knowledge)
- Research on high performance calculation flows (e.g. calculation, sequencing and optimisation algorithms) falls within the scope of research theme 8 (Big data and high performance computing: challenges and synergies for digital simulations)
- Research on modelling or optimisation of grid functionality falls within the scope of research theme 9 (Communication and processing infrastructures).
- Research on nanosciences and micro-technologies falls within the scope of research theme 10 (Micro-technologies and nanotechnologies for information and communication).

Basic research concerning challenge 7 (Information and communication society) that does not expressly fall within the scope of any other research themes of this challenge, of course fall within the scope of this research theme. This applies in particular to domains such as mathematics, automation and signal processing. However, proposals concerning basic research that falls within the scope of this research theme need to clearly explain how the research fits in with challenge 7 (Information and communication society). Research that is not directly related to this challenge falls within the scope of the All-Knowledge challenge.

Collaborative projects encompassing multiple informatics, systems engineering, communication, or mathematics domains pertaining to the basic aspects of challenge 7 (Information and communication society) likewise fall within the scope of this research theme.

Research theme 5: Software science and technology

This theme relates to basic and finalised research on software technologies in connection with the following topic areas: software tool infrastructures (e.g. operating systems, virtualisation, on-board systems, memory management); exploitation calculation models and middleware specific to various architectural principles (e.g. parallelism, distribution, real time); programming and specification languages and optimised compilation; software engineering (e.g. design methods; model based designs; agile methods, component and software architecture configuration and version management); software validation and analysis (e.g. test and debugging methods, program analysis, verification and proof of safety and security attributes; verification and optimisation of quantitative properties).

Research theme 6: Science and technology for confidence and digital security

Here, we are looking for research mainly on system engineering approaches for “controlled confidence levels,” in the face of the following: widespread use of mobile terminals; growing computerisation of communication and content; the development of social networks; and the development of cloud computing. Research on these matters should be user centred (regardless of whether such users are consumers or suppliers of services or content), and should enable users to maintain control over their data and communication.

This research can potentially encompass aspects related to privacy protection, identity management systems, or any other technological building block that promotes basic security as well as user confidence in new services. Design tools and the development of robust systems also fit in here. Research concerning anti-fraud measures or malicious use of systems falls within the scope of challenge 9.

Research theme 7: Human-machine interactions; connected objects; digital content; big data; knowledge

This research theme addresses the following three main characteristics of the digital revolution: the explosion of data and content, in terms of volume, diversity and rapidity of delivery (big data); the increasing intelligence of artefacts and their connectivity; and peoples' need to interact with an enriched cyber-physical environment that is also facilitated.

This type of interaction is based on multi-sensory interfaces that combine contact, gestures, movement, language, sight, visual sensors, context capture, and the user's psychological/physiological state, and can lead to wearable computing and human augmentation or extension technologies (e.g. intelligent glasses and watches, implants or ICM). We are looking for research that aims to improve interaction with the digital world, design new interactive objects and services, and create better tools for the development of such systems – a major issue requiring that (a) the user be integrated from the design stage; and (b) the multidisciplinary dimension of human-machine interaction be factored in throughout the entire process of creating the digital products of the future. This includes research on presenting information that will be most useful and intelligible for the user, who will be relying upon synthetic, personalised, and adaptive visualisations, as well as virtual conversational agents and avatars – all the while integrating virtual or augmented images and reality in order to create immersive environments.

These topic areas are related to notions of dynamic and interactive discovery of knowledge in increasingly big data – in other words, the *second challenge*. It addresses the issues of content and knowledge aggregation, manual or automatic annotation, multimedia and multilingual processing, semantic analysis, and knowledge modelling and representation. The use of interactive big data and open data or linked data require the capacity to deploy end to end development chains, including for big data: collection and integration of multi-source and incomplete data; automation of the extraction of domain related knowledge, databases, standards and ontologies; semantic interpretation of unstructured data; development of real-time predictive techniques.

The *third challenge* involves artefacts, including robots in various virtual or real forms, from humanoids to drones, as well as mobile machinery, tele-presence robots, exoskeletons and manufacturing robots – a field that is flourishing as never before, and that is having a massive impact on society, ranging from manufacturing production processes to assistance services. Above and beyond their necessary operational autonomy, the development of preliminary capacities in connection with artificial intelligence so as to allow for autonomous or joint action planning and decision making with people, along with more natural interaction with people, the study of cognitive architectures and learning capacities, are all subjects ripe for study – subjects that are poised to open up interdisciplinary fields of research with the life sciences and social sciences and the humanities.

The other artefacts that come into play are cyber-physical objects that are augmented by capacities in the realm of perception, calculation, memory, action, communication, interaction and connection in an Internet of objects, which poses major challenges.

This research needs to be co-ordinated with European projects and initiatives, particularly those pertaining to the European technological platform EURobotics and the Robotics PPP.

Research theme 8: big data and high performance computing: challenges and synergies for digital simulations

In many scientific domains (e.g. genomics, environment, climate, sciences of the universe, materials, sociology), technological and socio-economic domains (e.g. aeronautics, energy, pharmaceutical, manufacturing, digital, financial and service industries), the use of massive amounts of data and high

performance computing (HPC) capacities have triggered a data revolution. For this research theme, we are looking for interdisciplinary proposals (involving, for example, informaticians, analysts, mathematicians, statisticians and data scientists) who will contribute to the emergence of an interdisciplinary community in the realm of data and computing science. This research theme aims to eliminate the following barriers.

High performance computing (HPC)

This theme concerns the design and the development of software solutions in synergy with application domains, so as to address together massive, hierarchical and heterogeneous parallelism (computing and network capacity, memory access), energy efficiency and fault tolerance. Digital modelling and simulation methods for scaling algorithms and applications need to be rethought. The constraints imposed by hardware and by data management need to be integrated into the design of these methods (co-design). This research should be co-ordinated with European projects and initiatives, particularly those pertaining to the European technology PPP platform ETP4HPC and HPC PRACE infrastructures. Priority should be given to selecting the best European software and hardware platforms.

Management, analysis and use of the deluge of data

Most scientific applications are faced with a massive increase in the amount of data needing to be processed. As a result, we are now facing a potential breakdown in traditional data management flows involving data archiving for later analysis. The integration of big-data techniques and methods appears to be a first step toward solving the research problems arising from the volume and complexity of the data to be processed, whether these data be input or output scientific computing data (e.g. sensor data). All dimensions relating to big-data processing involved in simulation cycles come into play: tools and methods for production, management visualisation and computing. The full data life cycle issue as well as the integration of human into simulation workflows issue need to be addressed as a whole. This research theme includes the creation of new devices, metaphors, paradigms, algorithms, methods and tools.

Research theme 9: Infrastructures for Networking and Computing

This research theme relates to major technological changes that impact communication, information processing and storage infrastructures. These infrastructures are facing more and more challenging constraints on a number of aspects: in term of scalability, to face the volume of data to transport and process;; in terms of objects needing to be connected with the emergence of the Internet of Things; low latency for applications with high temporal constraints (e.g. long distance collaboration, e-health, networked games); strict security guarantees, especially for critical applications such as those related healthcare, the environment, or transportation, or those that may have an impact on the sovereignty; the quality of the user experience in all settings, in the face of massive user mobility; diversification of connected terminals and objects; management of energy consumption and cost. The convergence of technologies and market in communication networks, cloud computing, and data centres is also inducing profound changes. For example, today's network function virtualisation techniques allow these functions to be hosted on generic servers in the cloud, whereas heretofore this was realised using dedicated equipment. Software defined networks are likewise paving the way for unified software approaches to network and server management. All of these changes constitute major scientific, technological and economic challenges that the national community needs to address.

In this context of research, we are particularly calling for proposals in the following domains: flexible high performance optical communication systems; wired and wireless high speed and low latency networks; mobility, end to end security and resilience, content oriented networks, sensors and

actuators networks, Internet of things; virtualisation (network and system functions); Software Defined Networks; novel system and network architectures; convergent cloud-network-data centre optimisation and management; dynamic configuration and optimisation of heterogeneous resources (computing, storage, networks); orchestration and adaptation to applications and users' requirements; services discovery and orchestration in convergent infrastructures; optimisation and management of high performance and massive storage computing infrastructures; reduction of energy consumption. We are also looking for proposals in the field of infrastructure management and monitoring, with a major emphasis on software technology. These types of projects will be within also in the scope of the software science and technology research theme. And finally, proposals in basic-research related to systems and network theory and modelling, management of distributed infrastructures, and communication theory are also welcome in this theme.

The proposed research activities need to be co-ordinated with European projects and initiatives, particularly those pertaining to the European Technology Platform for communications networks and services "Networld" and the "5G advanced infrastructures for the future of Internet" Public-Private Partnership initiative.

Research theme 10: Information and communication micro-technologies and nanotechnologies

Progress and breakthroughs in the ICT domain are driven by, among other things, improvements in the performances of devices that process or transfer information. Such devices need to meet the following application challenges: energy efficiency; the deluge of data; system resilience. If the key generic technologies comprising electronics and photonics are bound to remain the lynchpins of information and communication systems, device integration into such systems remains a key issue nevertheless; and new paradigms based, for example, on the management of quantum properties or on bio-inspiration may also meet present and future ICT challenges. Proposed projects should address well identified scientific and technological challenges, and should aim to demonstrate (a) genuine performance improvements; or (b) that new technological ground has been broken. The domains that come into play for these barriers fall into four categories:

Elaboration, manufacturing and processing

of artificial materials or meta-materials for electronics or photonics constitute the basic technological building block for future successes.

Basic components and devices

Obtaining basic functions for micro-electronics, nano-electronics, spintronics, quantum optics, non-linear optics, near field optics, wavefront processing, millimetric domains, THz, nanophotonics, plasmonics, organic/flexible electronics and opto-electronics, quantum information, and neuromorphic components comprises a second essential building block, which also includes obtaining optical sources, fibre optics, and new components for optics and for micro-systems and nano-systems.

Architecture; integration; circuits

Photo-detection and the related imagers; laser and optical systems; communication circuits and systems (e.g. optics, RF); sensors; communicating, intelligent and autonomous objects partly involving heterogeneous 3D/integration methods or alternative architectures (e.g. bio-inspired, neuromorphic): all of these elements fall within the scope of this call for proposals.

Designs; simulations; characterisations; instrumentation

Digital approaches (components, materials, processes and complex systems simulations and/or designs), generic methodological approaches (designing, testing, metrology), and research into the reliability and advanced characterisation of nano-device materials and performance or basic components will allow for development of the necessary methods. Projects concerning imaging systems and instrumentation (e.g. THz, IR, X) could also be considered.

Projects can be mono-disciplinary, multi-disciplinary or inter-disciplinary. In their capacity as basic-research projects, they should aim to generate knowledge in connection with the challenge 7 issues. As technologically oriented projects, they should promote technology transfer to enterprises. Digital simulation, modelling, and theory may make a contribution to projects that are essentially experimental, or may form the subject of specific projects. Projects on topic areas from the European FET Flagship “Graphene” should explain the envisaged level of integration. In addition, projects that exhibit synergy with this initiative but that will be carried out by teams from three or more countries, can be submitted to the transnational call for proposals known as Flag-ERA (see section F).

Challenge Competitions as they relate to the challenge

The challenge competition funding instrument is described in section E.1.

Three challenge competitions will be initiated in connection with this challenge, and will be subject to specific call for proposal procedures. For further information, see the timeline of calls for proposals on the French National Research Agency website.

VIVIANES (Smart Vehicles in the City - Independent Navigation and Safety) challenge:

In connection with **societal challenge 6**: Beyond driver assistance systems, autonomous navigation functions in vehicles of future urban infrastructures would appear to be a natural evolution. The VIVIANES competition aims to encourage the development of low-cost solutions, which will be evaluated and compared in the frame of course of exacting contests.

DEFALS (detection of falsifications in images and videos) challenge:

At the interface between societal **challenges 7 and 9**, this challenge may open if the agreement with the funding partner, DGA (and possibly other co-funding entities) is finalized. The purpose of this challenge is to foster research in the areas of image and video analysis for integrity verification (blind detection of changes in real videos and images), and to promote closer ties between the image and optical communities, end users, and manufacturers.

RoMI (robots and intelligent machines) challenge

This challenge is related to **societal challenge 3**. As part of the “*Plan Robotique de la Nouvelle France Industrielle*” (Robotics plan for the new industrial France), major manufacturers have identified a set of scientific and technical barriers that are common to numerous stages of industrial process robotisation. The objective of this challenge is to contribute to the elimination of these barriers.

D-8) CHALLENGE 8 – INNOVATIVE, INCLUSIVE AND ADAPTIVE SOCIETIES

INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATION

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in [table 1 \(\\$F\)](#). The following countries are particularly relevant for this challenge:

- Germany; Austria; Switzerland;
- Turkey (SSH); Taiwan; Hong Kong;
- Brazil (SSH).

A complete list of European and international calls for proposals under the generic call for proposals can be found in [table 2 \(\\$F\)](#); the following elements come into play for this challenge:

- Franco-German (ANR-DFG agreement);
- Ora + (social sciences);
- Partnerships for International Research and Education (PIRE, NSF-ANR agreement)

=> These lists are provided for informational purposes only and are subject to change. Applicants who intend to carry out their projects in a European or international context should regularly visit the French National Research Agency website (<http://www.agence-nationale-recherche.fr/en>) to learn more about these partnerships and calls for proposals.

INTERFACES

This challenge encompasses research topics that are cross-cutting with other challenges. The other challenges that these topic areas fall within the scope of are indicated below, so that you can select the challenge that is most suitable for your research. Applicants should read the entirety of the challenge documents in question so as to familiarise themselves with their exact attributes.

Big data

For information concerning this cross-cutting area, which by and large falls within the scope of multiple challenges (including **challenge 8**), see [§ D](#) “Multi-disciplinarity, cross-cutting and interfaces” in the general introduction to the said section.

Social systems; migration: The socio-political and legal dimensions of environmental migration fall within the scope of **challenge 8**, as do disasters that reveal social divides. The debate concerning the

role of climatic or environmental migration in migration as a whole falls within the scope of **challenge 8**.

Changes in the working world: Changes in the working world at the factories of the future and in corporate networks fall within the scope of **challenge 3**.

More general changes in the working world in the industrial sector (contract precariousness; employment of the elderly and of migrants; mobility of highly skilled workers) fall within the scope of research theme 3 of **challenge 9**.

The **public health** aspects constitute a robust interface with **challenge 4** and will benefit from expertise pooling. The medical or epidemiological approach to healthcare inequalities falls within the scope of **challenge 4**, whereas their sociological or economic analyses (access to healthcare, health insurance, vulnerabilities, determinants related to social capital, healthcare, and inter-generational relationships) fall within the scope of **challenge 8**.

Digital society: Research themes 1, 2, and 3 of challenge 7 partly overlap with research theme 8. **Challenge 7** projects can be interdisciplinary, providing that they involve a significant amount of digital sciences research. Projects involving a substantial amount of humanities and social sciences research and whose digital dimension is limited to the use of state of the art tools fall within the scope of **challenge 8**.

Privacy protection: Privacy protection techniques fall within the scope of **challenge 9**. Research on the ethical and legal aspects of privacy protection in the face of big data falls within the scope of research theme 6 of **challenge 8**.

Violent radicalisation: Techniques for the detection of and fight against violent radicalisation fall within the scope of **challenge 9**. Violent radicalisation incorporated into the more general issue of immigrant integration falls within the scope of research theme 2 of **challenge 8**.

Introduction

In today's society, it is not possible to instigate positive social and economic evolutions without developing capacities for innovation, integration, and adaptation. Taking an analysis of attitudes toward risk as a starting point, challenge 8 explores the sources of innovation from a historical, comparative or prospective standpoint (research theme 1). It addresses the obstacles to integration constituted by inequality and discrimination (research theme 2). It also addresses changes in the working world, with an emphasis on gender equality at the workplace and regulatory levels (research theme 3). This challenge also involves proposals concerning new approaches to life-long learning and professional development (research theme 4), as well as recognition of heritage elements and creation (research theme 5). And finally, it involves the assessment of the positive and negative effects of digital technology on society (research theme 6). As these research themes are not specific to any given discipline, they can involve a broad spectrum of disciplines.

Research theme 1: Attitudes toward social risk and innovation

Today's society serves two masters, when it comes to risk: reducing the **aversion to risk** so as to pave the way for innovation; but at the same time fending off risks of all kinds – not only those related to social protection and insurance, but also those that have an adverse impact on the environment, human health, the food supply, private life, and the social contract. The result is nothing if not

paradoxical. Although **life expectancy** has been increasing for four decades at the rate of three months per year (i.e. six hours per day), this indicator of better protection of our lives is rarely mentioned in the public debate, because of the predominance of the notion that our lives are increasingly under threat – from globalisation, ageing, foreigners, and the abuse of nature.

The task here is to analyse the various manifestations of **attitudes toward risk**, in terms of demands for security, risky behaviours, having recourse to the precautionary principle, or entrepreneurship. The objective and subjective dimensions of the **relationship between science and society** also warrant investigation. But merely blaming so called resistance to change does not suffice, for it is necessary to look into the **capacity to live and make decisions in uncertainty**. Which individual and collective **creativity factors** are there? Cooperation or competition, concurrent or concerted investigation; hybridisation and homesickness; the urgency of wartime; investigation of serendipitous findings; alternative scenarios; abductive inferences: these are all sources or methods that call decision making and inventive design theories into question and that can be studied for specific cases that arise in an extremely broad range of settings.

Innovation is driven by numerous elements: governments, businesses, municipalities and individuals – but also intermediary or associative groups that are engaged in social innovation in order to meet social and environmental needs and experiment with new forms of use. Innovation is not a new idea. Cities are innovative spaces par excellence, and succeed to a greater or lesser extent in this endeavour, as archaeological findings and urban studies show. Throughout history, individuals or groups have broken with or defied the status quo so as to envisage a different kind of life, different ways of doing things and new belief systems or systems of thought: utopians, heretics, prophets, artists, inventors, pioneers, migrants, and so on. In the 19th and 20th centuries, innovations flourished, e.g. team teaching, freedom of the press, attempts at participatory democracy – not to mention the advent of religious and humanitarian movements. Taking its cue from precursors from as far back as Condorcet and Malthus, the demographic revolution is a civil-society innovation that is advancing apace: birth control, family planning, reproductive rights, female empowerment, children’s rights, diversity of family forms.

The **right of French municipalities to experiment**, which is enshrined in the French Constitution, is a prime example of the kinds of problems that innovation transfer can provoke. The sale of start-ups to large companies is another example. Of interest here is the change in the scale of the innovations that are conveyed by a large company, the legislature, or an international organisation – particularly if the problems discussed are of a cross-border nature. If conducted from a historical or comparative standpoint, such research could potentially propose new instruments for public action.

Research theme 2: Inequality, discrimination, integration

As a major obstacle to social integration, **growing inequality** needs to be quantified and elucidated in all of its various dimensions. The following can be investigated in this regard: the degree of integration or retreat on the part of various social groups, the logic of exclusion at both ends of the social scale, and the disconnect between actual and perceived inequality. Likewise worth investigating are the interactions between social and spatial inequality, the complex nature of segregation, as well as residential mobility as a de-enslavement factor. The types of healthcare inequality that come into play for the challenge being considered here should be studied from a geographical and social standpoint (access to healthcare; patient-doctor relationships; health insurance; medical “wastelands;” role of social capital; healthcare practices) in both senses of causality (social determinants of health, effects of health on social status). All of these topic areas are potentially related to the current debate concerning the principles of justice, including territorial justice and the controversial issue of “appropriate inequality.”

Europe is a continent of **immigrants**. According to French government statistics, one of four persons living in France is an immigrant (i.e. first generation) or was born to at least one immigrant parent in France (i.e. second generation). Does it still make sense to ask whether this 25 percent of the French population is integrated with the remaining 75 percent, given the fact that this 25 percent contributes more than it costs? Migration should be analysed as a settlement and circulation phenomenon; while at the same time researchers in this field should remain attentive to the spectrum of migration factors that come into play in the country of origin and the destination country: work; education; marriage; refuge; retirement; the search for security or emancipation, etc. Likewise worth investigating is the tendency on the part of both immigrants and natives to emphasise religious or secular cultural identity. Likewise worthy of consideration are attempts on the part of peace studies or counter violent extremism (CVE) research to shed light on the logic of violent radicalisation, an extreme case being the recruitment of young jihadists over the Internet. How can the “national narrative” be renewed, based on a plausible civil frame of reference that takes the diversity of origins into account?

All of these issues can be addressed from both a national and international standpoint. They could also be extended to include **historical or pre-historic** elements, which throughout history have sometimes divided and sometimes united a plurality of cultures.

Integration is not a very appropriate term in cases where, in the presence of individuals with the same qualifications, **discrimination** bars access to key goods and services: education, job training, employment, promotion, housing, public spaces, leisure time activities, a quality environment. The French penal code contains myriad criteria that can potentially be considered “discriminatory” in the eyes of the law: age, gender, physical appearance, nationality, ethnic origin, membership in a political party or trade union, religion, surname, state of health, disabilities, pregnancy, sexual identity or orientation, and most recently, home address. By no means has research concerning all of these forms of discrimination progressed to an equal extent, and even less for the cumulative aspects of these types of discrimination.

Discrimination can take many forms: it can be direct, indirect, systemic, statistical or associated with interpersonal relationships; or it can occur in urban spaces and/or workplaces. Statistical discrimination, as defined by the economists Arrow and Phelps, is driven by risk aversion, in that rejecting someone on the basis of their physical appearance presupposes a “risk” category (e.g. the risk of pregnancy, or the “danger” deduced from racial or ethnic profiling). As for the potential victims of discrimination, they may well presume that they are going to be excluded and simply not bother to show up. This Bayesian mindset is more difficult to combat than direct discrimination. Studies of social cognition underscore the substantial increase in prejudice in making choices that expressly attempt to prevent it. These paradoxes need to be analysed, and we need to bear in mind that in order to prove the existence of discrimination, suitable methods are needed (backed up by examples from foreign cultures): CV testing for obstacles to access, longitudinal monitoring of careers, explicit or implicit prejudice measurement methods.

Researchers wishing to conduct projects on discrimination measurement should contact **private companies or government agencies**. Do the latter use the methodological guide titled *Mesurer pour progresser vers l'égalité des chances*, which was published for these agencies in 2012 by the CNIL and the *défenseur des droits* (constitutional rights ombudsman)? The goal here is not so much quantification as elaboration of behaviour models and testing practical solutions, i.e. rethinking selection tests, recruiting employees from sectors other than the conventional ones, instituting affirmative action programs, and hiring an employee who devotes themselves full time to combating discrimination.

Research theme 3: Changes in the working world; workplace equality

Globalisation goes hand in hand with **changes in the working world**. In the face of financial crisis and economic recession, national **employment models** are being called into question. The relationship between employment and the social safety net/welfare state is no longer a given. Jobs are becoming ever more precarious (full time jobs, temp jobs, atypical working hours). On what scale should the labour market be organised? How can the unemployment rate among immigrants, their spouses and their descendants be lowered? What needs to be done in order for France's highly skilled workers to reap the benefits of cross-border mobility? How can innovation be brought about in the forms of transitioning to retirement? The following three issues arise in this regard: work as a creativity and integration factor; revamping legal frameworks; full employment for women.

Although individualisation and solidarity are often described as polar opposites, **integration through work** remains a key source of individual recognition and group creativity. Research in this domain should focus on the following: new human resource management practices; the possibility of businesses elaborating standards (equal opportunity, diversity management and so on); changes in the working world.

Legal frameworks raise related issues. Jurisprudence is losing ground to the concept of law as a practical resource. The flexible procedures of so called soft law are continuing to make inroads, in the guise of arbitration, negotiation and mediation. Collective wage agreements are on the wane, while the search for flexibility is promoting decentralisation of rule definition and changes in the way the social dialogue is framed. These changes can be studied by comparing work environments with national contexts.

The issue of the **scale of regulations** could also be extended to the following additional areas: the dual pressure exerted by local and supranational elements on domestic regulations; the new forms of confrontation between economic and political stakeholders (e.g. the invocation of “economic patriotism” in negotiations on company acquisitions and layoffs); and beyond this, the crisis of democratic representation in France and Europe. Such research should foreground the experiences engendered by legislative changes.

If **work-life balance** has long been a preoccupation of French politicians, **workplace equality** has lagged far behind, owing to the enormous pressures to which working women are subject. Their double working days become triple working days in cases where they hold a job *and* perform parenting tasks *and* tend to the needs of an ailing parent of their own. Research on social activities should centre around technical, legal, fiscal, political and other solutions that have the wherewithal to counter male domination. The main stumbling blocks in this regard are well known. Men fail to do their fair share of housework and parenting, while social norms still exert pressure on women to undertake work that is reputed to be altruistic or free of bias – but that is often undervalued (education, healthcare, jobs in cultural institutions, or the service sector). The solutions adopted by Nordic countries to counteract these two tendencies – parental leave for men, female quotas for boards of directors or recruitment committees – are beginning gain hold in Europe. It is urgently necessary to evaluate these innovations and investigate the conditions that have led to their being widely disseminated.

Research theme 4: Life-long education and professional development

In a society that is in constant flux, a person's **skills and abilities** change and evolve at each stage of their life, from early infancy to adulthood.

For many years, the importance of **early sensory, cognitive and linguistic development**, stimulated by the child's environment, was underestimated. Investigating these issues could lay the groundwork

for the development of pedagogic methods that unleash children’s potential while learning basic skills (self-expression, reading, writing, counting) and that develop intellectual, affective and social aptitudes, e.g. a practical sense, imagination, sociability, and self-confidence.

The 2012 PISA study’s findings on France concerning the **academic performance** of 15 year olds were disconcerting: decreased mean average level in math; growing proportion of students experiencing tremendous difficulties; an increase in social inequality over the past decade. In no other OECD country do the social origins of children play such a major role in scholastic failure as they do in France. And as for French institutions of higher education, the dropout rate is in free-fall, with one in five students failing to earn a degree. The findings for France in the 2013 OECD study on the ability of adults to use written information were also disappointing.

Research here should centre around ways to improve the **performance of the education and job training system**, so as to decrease the unemployment rate and increase the chances of success for career transitions. This could involve the following: rethinking an orientation system that is mainly based on elimination; orient learning more toward carrying out real tasks under real conditions, including in the sciences; initiate or improve training for selected skills (source code, education, art, debating techniques); develop a professional teaching corps; support informal education. Efforts should also be made to analyse the relevant factors: the initial potential of children (which is reduced by sensory, motor or cognitive disabilities); social inequality (in terms of income, linguistic/cultural codes, gender norms, family make-up, impact of a particular neighbourhood); the effects attributable to various dimensions of the school per se (classes, teachers, administrators). We would welcome proposals concerning research on government educational and job training policy, for each of the types of research referred to above.

The **rich history of educational innovations** is also worthy of study. Here, it is necessary to take into account that inter-generational transmission of culture that is observed in humans and other species, in human beings is based on complex cognitive mechanisms that develop in response to changes in the environment (the development of bi-pedalism; tool making; language acquisition; social interactions). Human beings are learning animals, who also have the capacity to learn how to learn. The digital era (see the research theme devoted to this topic) has added a new chapter to the annals of this long history of adaptation.

Languages both facilitate and get in the way of communication. The European Commission’s 2003 action plan on **language learning and linguistic diversity** failed to spread the practice, in Europe, of speaking two foreign languages, as English has continued to make inroads. We would welcome projects involving innovations for the acquisition of a third language, in addition to the first language and lingua franca (research on automatic language processing falls within the scope of research theme 6 concerning the digital realm).

Research theme 5: Cultures, heritage, creation

Heritage, artistic and cultural activities are a source of prestige and revenue, and promote social and national harmony. But globalisation, which promotes local identity, is also a game changer. In the view of the Council of Europe (though this also holds true outside of Europe), a heritage rests on a community, whether it be local, national or international. A people recognises in its heritage its history, language, habitat and landscapes. The concept of heritage also extends to new spheres, namely the technical, scientific, customs, immaterial and environmental spheres. In connection with this multi-form process of heritage consolidation and recognition, we are seeking research that will define the respective role of public, private and quasi-private stakeholders, in a manner that takes care to compare the French case with foreign experiences and historical evolutions.

If the process of heritage recognition tries to attract the public through cultural events, the figure of **the creator** remains highly individual. Economic analyses of creation underscore the surfeit of callings, the uncertainty of deriving any benefit from creation, and the tremendous inequality in the sphere of success – which the culture industry greatly accentuates. The ideal of the creator becomes the production of a work that is at once an individual and mass work, both singular and universal. It remains to be seen whether international exchanges on artistic experience will make it possible to transcend cultural differences and training level inequality.

The archiving and dissemination capacities that are available today have wrought a change in **attitudes toward culture and heritage**. But to what extent? The culture industry would rather manage immaterial flows than physical inventories. And thus we end up consuming books and DVDs online instead of storing them at home. Does this have an impact on creative production? Does it change the public? Another renewal path worth exploring is the possibility of a less ethnocentric take on ancient works of art or on works of art from far-off lands. The idea here is to no longer extract these works from their context, but instead to put them back into their original context, and in so doing endeavour to acquire the necessary cultural knowledge. But who would be able to meet these exacting requirements, and how far would such a person go? Perspectives of this nature could potentially contribute a great deal to cultural exchanges, the ever changing hierarchy of gestures, inter-textual links, and the mobility of creators, from one art to another.

The **cultures of science, technology and industry** benefit from this recognition, but remain on the sidelines when it comes to other cultural fields. Will these cultures ultimately alter the criteria we apply when making judgements? Hence neuroscientists endeavour to capture the power of artistic emotions using brain imagery. Such experiments have shown that the neuronal activity of connoisseurs is more intense than that of neophytes. Is activating mirror neurons that “mimic” the movements of a work of art the right thing to do? Research of this nature needs to be compared with historical or sociological experiments that have attempted to relate artistic emotion to values such as symbolic power, authenticity, harmony, the force of breaking away, rarity and so on. Such values are undoubtedly perceived differently depending on the reference culture and level of knowledge. Hence there are three mechanisms – the socialisation of taste, inducing artistic emotions, and their neuronal facilitation – that could be used to understand the relevant sequences and interactions, without losing sight of the future evolution of art education, artistic practice, and cultural and intercultural training in general.

Research theme 6: Digital revolution and social change

For the humanities and social sciences, digital technology is both a tool and a research area. Apart from the **corpus** on habitats and works on languages, it is necessary to consolidate sociopolitical, demographic and geographical **databases**, provided that they are documented and access to them is open. **Cohorts** are a key monitoring tool, a domain in which the ELFE and SHARE studies have broken new ground concerning early infancy and transitioning to retirement. These studies could be a platform for projects – but other stages of life should also be studied. The European Social Survey is a platform that French researchers should take greater advantage of. We would also welcome research that combines studies with administrative and contextual data.

Another element is **big data** derived from the capture of user traces – the information of choice for research, as well as decision making aids, provided these elements constitute open data. But the fact is that big data is so opaque and massive that it is easy to assume that it is “theory free.” Do researchers need to abandon efforts to question the genesis and representativeness of big data, grasp the meaning of terms and categories, and distinguish between cause and effect? The recent controversy over the accuracy of “Google’s flu trends” (March 2014), as an example of

crowdsourcing capable of replacing the statistical apparatus, provides food for thought. The predictive capacity of individual requests on the flu epidemic (15 words, whose list was not revealed) comes as no surprise, insofar as the goal is to anticipate the seasonal profile of data from the CDC in Atlanta; but such requests led to a logjam when it came to the H1N1 epidemic of 2009. How can users' take on reality be modelled? How can the unforeseen be differentiated from the periodic? How can a non-public protocol be evaluated?

Digital advances in research domains such as social life run up against a **linguistic barrier**. Projects that aim to make a qualitative leap into the realm of Natural Language Processing (NLP) and toward natural-language modelling and assisted translation of databases fall within the scope of the challenge under consideration here, insofar as such projects are based on an analysis of linguistic codes and structures. The same applies to analyses of controversies and argumentation for research, teaching and civic education purposes, if such analyses go beyond classic studies of vocabulary and allow for farther reaching analyses of social discourse.

Digital technology changes our relationship to the territorial realm and alters the frontiers between work and private life and between experts and amateurs. Tele-work, instant access to services and the virtual extension of reality are forms of progress that raise hopes of unprecedented **gains in productivity**. But unfortunately, the economic growth rate of the best equipped countries has not kept pace. The debate concerning the **Solow paradox** is continuing, and French research needs to continue to contribute to this debate. But the facts remain to be established.

The **impact of digital technology on social structures** calls for research on specific issues. What should we make of the creation and destruction of occupations? Does the dematerialization of services wreak havoc with the scale of job qualifications? Has it opened new paths to social mobility? And if social networks intensify contact as never before, do they modify the structures of sociability – namely the propensity to frequent one's environment and choose a partner there?

The **impact of digital technology on cultural practices** is varied. Self-production of content, the ubiquity of recorded music, and the exponential growth of social networks have preserved infelicitous tendencies: reading was already on the decline before the advent of the Internet; attending live performances (theatre, concerts and so on) and visiting museums remain the province of an elite. What contribution has digital technology made to the democratisation of knowledge and culture? Can it reduce the propensity to tune out, when the disparities in high school academic level, according to social origin, have increased in a mere ten years? All of these issues remain unresolved. Without a reorganisation strategy, digital tools cannot hope to transform secondary or higher education – which is why research is urgently needed on the conditions that need to be met in order to define an economic model for MOOCs (which have now become a priority) and their variants, and ensure their success.

The **impact of digital technology on behaviour** is ambivalent, since the Internet can be the source of the disease and the remedy at the same time (like plagiarism and its detection). Have video games exacerbated or channelled violence? Do they modify cognitive capacities? Is sitting in front of a screen more socially isolating than being absorbed in a book? Does the promise of networks pan out in reality? Addressing these issues will help to avoid the pitfall of imputing to digital tools effects attributable to user characteristics, and vice versa.

The **ethical issues raised by digital technology** also need to be addressed. What is the nature of this unique social contract, which guarantees each individual the right to connect to the Internet, in exchange for user data tracking and mass profiling? How can selling third parties the gratis work

products of users be justified? Would it suffice to transform big data into a public good? Is ubiquitous encryption the wave of the future? How can the right to oblivion be guaranteed? This is only an initial series of issues; others could also come into play.

D-9) CHALLENGE 9 – FREEDOM AND SECURITY OF EUROPE, ITS CITIZENS AND ITS RESIDENTS

INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATION

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in section in [table 1 \(§F\)](#)

INTERFACES

This challenge encompasses research topics that are cross-cutting with other challenges. The other challenges that these topic areas fall within the scope of are indicated below, so that you can select the challenge that is most suitable for your research. Applicants should read the entirety of the challenge documents in question so as to familiarise themselves with their exact attributes.

Big data; biology; sensors; robotics

For information concerning these cross-cutting areas, which by and large fall within the scope of multiple challenges (including **challenge 9**), see [§ D](#) “Multi-disciplinarity, cross-cutting and interfaces” in the general introduction to the said section.

Urban infrastructures: Research on generic issues related to security (not specifically related to identified risks and threats) and/or overall problems encompassing security that are not the main topic area fall within the scope of **challenge 6**.

Environmental risks: Crisis management from an operational, logistical, economic or other standpoint falls within the scope of **challenge 9**. Natural risks and the possible origins of a crisis (e.g. characterisation of the hazard and of the relevant risk factors, observational tools and methods), preventive systems, threat evaluation and alert thresholds all fall within the scope of **challenge 1**.

Information system security: Research that aims to improve the intrinsic security properties of a given information system, or that relate to design and development tools, fall within the scope of **challenge 7**

Privacy protection: Privacy protection techniques fall within the scope of **challenge 9**. Research focused on the ethical and legal aspects of privacy protection in the face of big data falls within the scope of research theme 6 of **challenge 8**.

Violent radicalisation: Techniques for the detection of and fight against violent radicalisation fall within the scope of **challenge 9**. Violent radicalisation incorporated into the more general issue of immigrant integration falls within the scope of research theme 2 of **challenge 8**.

Introduction

Management of **physical security** and **cybersecurity** in today's complex and interconnected society in a manner that safeguards civil liberties represents a major social and economic challenge. In the face of economic competition, ever changing risks and threats, and society's growing dependence on new technologies, security research is key when it comes to meeting users' and citizens' needs, and maintaining French competitiveness.

This challenge aims to help develop **new security solutions** that complement Europe's Horizon 2020 programme and that are consistent with the structuring of the French security industrial sector and both French²⁷ and European priorities.

Research in this domain can relate to **risks and threats of all kinds** (i.e. natural, provoked, physical and digital threats): natural disasters, technological accidents, malicious acts, terrorism, and criminal acts. The solutions in this regard need to contribute to the improvement of one or more phases of an event that is a threat to security: information, surveillance, analyses, anticipation and prevention of risks and threats; early detection, alerts and crisis management (intervention and restoration); **resilience**, and post-event judicial investigations.

The effectiveness of any security system is determined by the quality of the **interaction between its technological, organisational and human components**. Thus **interdisciplinarity** is a key to success (social sciences and humanities, physics, engineering, chemistry, life sciences, mathematics, logistics and organisational aspects). This challenge aims to bring the research community together and break new ground in respect to all topic areas related to security as a whole (**global security**)²⁸. Hence, we are looking for greater participation on the part of stakeholders in the following domains: basic research, cyber-security research; SSH (e.g. political science, law, sociology, ethnology, anthropology, management, economics, psychology, ergonomics); risk assessment, prevention and management.

This challenge places particular importance on **respect for ethics, freedom and privacy**, and on promoting these values – which need to be factored into all of this challenge's research themes.

Research here should preferably involve collaboration with **business and academic partners**, as well as public and private domain end users, prescribers or operators – including stakeholders from the insurance industry. However, any of the available funding instruments may be proposed. For all research themes, projects can involve basic research or research that is farther along (TRL 1 to 5-6²⁹).

This challenge is divided into six research themes:

- Citizen security/safety; combating crime and terrorism
- Safeguarding networks and vitally important infrastructures

²⁷ *Liberté et sécurité de l'Europe, de ses citoyens et de ses résidents* workshop the *Stratégie Nationale de Recherche (2014)* and *Livre Blanc Pour la Défense et la Sécurité Nationale*, 29 April 2013.

²⁸ This notion includes both safety and security concepts.

²⁹ Technology readiness level scale ranging from 1 to 9.

- Risks; crisis management, regardless of origin and/or resilience
- Surveillance of sea, land and airspace
- Cyber-security and the fight against cybercrime
- Security, freedom, privacy protection, and civil liberties

Research theme 1: Citizen security/safety; combating crime and terrorism

This research theme encompasses the following: the fight against **terrorism** (including CBRN-E³⁰) and **serious crime**; problems related to “minor” crime and **delinquency**; evidence gathering and admissibility in connection with police investigations; rescue operations; protection of first responders; identity management. For this research theme, it is necessary to identify and avert risks and threats at the earliest possible stage (including via new filtering techniques and big-data analyses), manage the consequences of these risks and threats and allow for the identification of the relevant perpetrators. This theme also encompasses areas such as violent radicalisation of individuals or groups, and improving the security and safety of urban populations. In this research theme, particular importance will be placed on compliance with laws concerning the protection of basic rights.

Projects whose main focus is on freedom and privacy protection related to security matters fall within the scope of research theme 6 of this challenge. Projects that mainly focus on cyber-security for citizens fall within the scope of research theme 5 of this challenge.

Research theme 2: Safeguarding networks and vitally important infrastructures

This research centres around the search for ground-breaking solutions aimed at improving the **protection of grids/networks and critical infrastructures** (and the related services), particularly in respect to energy, the water supply, transportation, telecommunication, and the interdependency between these infrastructures and with other infrastructures; and in particular in order to improve the prevention and management of cascading disasters (domino effect). This theme also encompasses research on sensitive facilities and combined natural and technological risks (natech).

Research here can centre around the characterisation and impact assessment of risk/threat scenarios, and physical and digital protection of infrastructures against the whole gamut of risks and threats: detection of malicious individuals; perimeter protection; protection against CBRN-E threats (understanding, evaluation, remote detection, identification, physical and organisational protection, decontamination); development of design methodologies for secure infrastructures that are resistant to all types of aggression, that are based on the use of predictive physical models (models for effect simulation, structural resistance, breakdowns, malfunctions, sabotage, exogenous attacks, endogenous attacks) and that promote the propagation of an across the board security by design approach; cybersecurity (particularly by design) of critical connected and intelligent infrastructures and networks/grids, particularly via security management of SCADA industrial information systems. These various approaches can draw upon technologies from the following realms: innovative materials (e.g. self-decontaminants); sensors (in particular, but not only, for video surveillance) that are integrated, intelligent and safeguard civil liberties; modelling techniques; physical and digital management and control techniques; monitoring system integration (supervisors).

³⁰ Chemical, biological, radiological, nuclear and explosive

This research theme also encompasses the protection of restricted zones, particularly for airport security (tools allowing for the monitoring and tracking of personnel movements within various zones, and in a manner that protects privacy).

Research theme 3: Risks; crisis management, regardless of origin and/or resilience

This research theme focuses on **crisis management**, regardless of the cause of a crisis (negligence, malicious acts, natural or accidental disasters, security implications of the economic crisis) that provokes a disaster or series of disasters. Crisis management in this context involves the temporal phase in respect to the following:

- **Analysis, anticipation, evaluation and prevention of risks and threats, with extensive involvement of SSHs:** promoting overarching approaches to risk and vulnerability analysis and management that fold in the technological, organisational and human dimensions; behavioural analyses in the face of risk; subjective and decision-making social and cognitive processes; combining insurance and probabilistic analyses with technological approaches, in order to develop new governance and business models that promote better prevention; estimates of physical and economic damage; prevention rules and regulations; taking cost-benefit and cost avoidance factors into account so as to allow for advance provisioning of guidance concerning security and risk management choices; combined safety and risk management measures.
- **Early detection of crises that may be on the horizon, and management of actual crises, via an integrated approach:**
 - Modelling and simulation of critical phenomena; real time acquisition, processing and management of hybrid and multi-source data (big data and crowdsourcing); rescue and evacuation modelling in the event of a crisis; promoting the intelligence of decisions and actions during critical phases (e.g. assistance with multi-criteria decisions; human-machine interaction); interactive prevention and alert management at the individual level as well as for the general population.
 - The resources, tools and logistics for rescue worker interventions: evacuation, victim triage, medical treatment, robots and drones to aid rescue workers; telecommunication; and so on.
- **Resilience:** assessment methodologies concerning the vulnerability and resilience of complex systems (network theory, decentralisation, coordination); approaches and tools that support the design of resilient devices (e.g. fault and degradation tolerance); resilience and security of large urban areas (closely related to the concept of smart cities); methodologies for feedback assessment.

Research theme 4: Surveillance of sea, land and airspace

This research theme concerns **sea, land and airspace surveillance**, managing the security of human, material (logistics chain) and immaterial flows, and the interplay between these various spaces. Issues such as the fight against all types of trafficking, as well as piracy and other illegal activities, can be addressed under this research theme. Research here can encompass technological issues (e.g. sensors, event correlation, ways of taking action) and/or can relate to the humanities and social sciences (law, political science and so on). Particular emphasis will be placed on evolutions in Europe.

Research theme 5: Cyber-security and the fight against cybercrime

The growing **dematerialization** of human activities has given rise to new risks and threats (related to dependence on digital technology), which are on the rise in today's highly interconnected society. Hence, increased crime and the hacking of information and communication systems, or their use to create or multiply more traditional criminal activities, constitute a major threat for European and national institutions and authorities, infrastructures and grids/networks as well as for the general public. Thus research on security solutions that are suitable for cyberspace is essential.

Such research should allow for the **assessment of cybercrime threats** and for analyses of their impact (macro-economic, material and so on). Such research should also address methods, resources and tools that facilitate the fight against cybercrime and that meet the needs of information system security (ISS) for the protection of institutions, infrastructures, networks, tangible and intangible heritage elements, as well as the citizens.

ISS research could address the following matters:

- Design, validation and verification of **secured components**, and protecting them against attacks by auxiliary channels.
- **Application security**, particularly for the handling of sensitive information (confidentiality, privacy) and to prevent reverse engineering.
- **Steganography, cryptography, and crypto-analysis.**
- Security of **authentication** systems (biometry and multimedia documents).
- Protection against fraud and **falsification** of digital documents (dematerialised documents, electronic voting protocols).
- **Intrusion** detection and the implementation of comprehensive cyber-surveillance and alarm systems; resistance to attacks against information and communication systems and/or embedded systems, by designing and certifying systems that demonstrate their resistance to cyberattacks (logic, formal proof).

Anti-cybercrime research could potentially address the following matters:

- **Weak-signal** detection in big data flows; behavioural analyses; content processing (language, videosurveillance, Internet) while still protecting privacy during data collection phases (anonymisation of information gathered; anti-correlation measures).
- New **forensic** tools and methods; risk and threat detection.
- **Virology** and **anti-malware** measures.

Finally, as ISS hinges in large measure on users, this research could focus on actions aimed at raising user awareness, and providing cybersecurity stakeholders with training.

Research theme 6: Security, freedom privacy protection, and civil liberties

Certain aspects of **public safety** go hand in hand with new forms of encroachment on **privacy**. Remedying this will necessitate a new generation of hybrid research combining technological and social knowledge (in the fields of sociology, law, political science, criminology and so forth). Moreover, freedom necessitates the capacity to make decisions, and thus information and training for the citizens; and protecting individuals who are in a vulnerable situation.

The aim of this research theme is to reconcile the protection of civil liberties with public safety, in particular by means of technological translation (into design rules) of concepts such as privacy by

design in all of its dimensions (legal, socio-anthropological, and ethical), while still making allowances for the major differences between the French and Anglo-American approaches. It is particularly necessary for research to be conducted in this domain by introducing this notion concurrently with the development of new technologies, so that, for the research process, such technologies can take into account social acceptability constraints and the changes envisaged by the reform of European data privacy regulations. Although, when applied to cyberspace, the concept of privacy by design constitutes a design basis (e-confidence, digital identities, laws applicable to cyberspace and social media, smart grids), this concept does not encompass the entirety of the field that needs to be covered (issues such as videosurveillance, geolocalisation, file interconnection and management). This research theme also relates to the development of privacy enhancement technologies: techniques for database anonymisation³¹, data minimisation, data tracking and so on.

Challenge competitions as they relate to the challenge

The challenge competition funding instrument is described in section E.1.

A challenge competition will be initiated in connection with this challenge, and will be subject to specific call for proposal procedures. For further information, see the calendar of calls for proposals on the French National Research Agency website.

The DEFALS (detection of falsifications in images and videos) challenge competition:

The realisation of this challenge competition, which lies at the interface between challenges 7 and 9, is contingent upon entering into an agreement with the partner, DGA (and possibly other co-funding entities). The purpose of this challenge is to bring about advances in research on image and video analysis, for purposes of integrity verification (blind detection of changes in real videos and images), and to promote closer ties between the image and optical communities, end users, and manufacturers.

³¹ G29 (group of European data protection authorities, April 2014): http://ec.europa.eu/justice/data-protection/article-29/documentation/opinion-recommendation/files/2014/wp216_en.pdf

D-10) ALL-KNOWLEDGE CHALLENGE (DEFSAV)

INSTRUMENTS APPLICABLE TO THE GENERIC CALL FOR PROPOSALS

Applicants wishing to submit a pre-proposal for the 2015 generic call for proposals will need to select one of the following instruments, which are described in detail in section B:

PRC PRCE PRCI JCJC

EUROPEAN AND INTERNATIONAL COLLABORATION

This challenge falls within the scope of the development of European and international research. The indications below are intended to provide French teams with information concerning agreements that have been concluded or that are in the pipeline between the French National Research Agency and its foreign counterparts, for the purpose of establishing international projects and consortiums.

A list of the partnerships that fall within the scope of a bilateral agreement under the generic call for proposals can be found in [table 1 \(\\$F\)](#). The following countries are particularly relevant for this challenge:

- Germany; Austria; Switzerland;
- Taiwan; Hong Kong; Singapore; China; India; Turkey
- Brazil; Canada.

A complete list of European and international calls for proposals under the generic call for proposals can be found in [table 2 \(\\$F\)](#); the following elements come into play for this challenge:

- Franco-German call for proposals concerning French National Research Agency-DFG SSH

=> These lists are provided for informational purposes only and are subject to change. Applicants who intend to carry out their projects in a European or international context should regularly visit the French National Research Agency website (<http://www.agence-nationale-recherche.fr/en>) to learn more about these partnerships and calls for proposals.

Introduction

The All-Knowledge challenge (DefSav) constitutes an indispensable action for the *At theFrontiers of Research* component of the Work Programme 2015, and is a continuation of its counterpart element in the 2014 Work Programme. The purpose of this continuity is to afford all scientific communities the opportunity to apply for funding for projects that clearly do not fall within the scope of the societal challenges, and to round out, from another standpoint, the dedicated measures for the nine societal challenges – which are eligible for basic research within their clearly delineated thematic scopes.

The *At the Frontiers of Research* component of the 2015 Work Programme also includes the OH Risk programme which aim to promote scientific creativity for high scientific potential research areas where risks mainly arise from the absence of literature published as yet in these areas (see the description of the programme in section E-2).

A specific challenge centring around research at the frontiers of knowledge

The All-Knowledge Challenge aims to encourage prospective or exploratory research that could potentially expand the frontiers of knowledge. Such research is particularly valuable in that it is in reference to these frontiers that society constructs its capacity to evolve and project itself into the future. This need for knowledge, whether it involves the quest for understanding the world around us and the laws that govern it, or the desire to develop abstractions, will thus have a major impact on future decisions far exceeding the bounds of its initial quest.

Against this backdrop, the All-Knowledge Challenge aims to support development and scientific advances (whether or not they are in line with established schools of thought) based on curiosity, creativity, observation, and in some respects, risk-taking. Inasmuch as it lies at the heart of such projects, the issue of knowledge should also be a driver of discovery the implications of which are not always foreseeable, but which are essential when it comes to anticipating change and addressing the societal issues of the future.

The All-Knowledge Challenge also aims to promote advances in the major areas of knowledge that influence research over the long term. For knowledge can be the driver of breakthroughs, and of new concepts and paradigms, some of which are bound to become the source of applied or industrial developments in the coming years. Reaching this goal is essential for French industrial renewal.

The All-Knowledge Challenge may also form the basis for the development of integrated approaches, which may in particular involve the development of generic tools and/or methods and the integration of various inputs, above all from an interdisciplinary standpoint. Such approaches that harbour great potential, but whose impact will not be immediately felt, merit support for their intrinsic internal dynamics – which are barely visible from today's social problems standpoint.

The scientific excellence of the proposals in this domain will be a decisive criterion, the goal being to go beyond the boundaries of issues raised in the general context of a societal challenge or a particular field of investigation within such challenge.

The goal of the All-Knowledge Challenge is to generate the critical mass necessary for the emergence of new scientific and technological concepts that have the capacity to form valuable capital for the future.

Priority research areas and suitable research instruments

Research at the frontiers of knowledge in areas such as **astrophysics, basic physics, particle physics, the structure and history of the Earth, chemistry, certain fields in the humanities and social sciences, and certain components of basic biology or basic mathematics** applies to this funding mechanism for projects lying beyond the scope of the major societal challenges.

The funding instruments available for the All-Knowledge Challenge are the same as those for the societal challenges.

Project proposals for this challenge can use any type of approach, from theory to instrumentation.

This challenge falls within the scope of the generic call for proposals. The selection process will be

the same as and concomitant with the process for societal challenges. Pre-proposal selection will mainly be based on measurement criterion concerning the extent to which the proposal is (a) compatible with the All-Knowledge Challenge objectives and (b) incompatible with the objectives of one or more of the societal challenges.

Researchers wishing to submit a pre-proposal for the All-Knowledge Challenge are therefore advised to carefully read the descriptions of the societal challenges, so as to be able to successfully demonstrate that their work falls outside the scope of the research themes and fields underlying them.

E. Other calls for proposals and programmes under the Work Programme 2015

The Work Programme 2015 proposes various possible funding instruments, each of which has its own specific anticipated effects and its own distinct characteristics in terms of evaluation and monitoring. In this section, we describe the funding instruments that can be used outside the scope of the generic call for proposals. These instruments are subject to specific programmes or calls for proposals whose timelines are available on the ANR website.

“Major societal challenges” component

E-1) CHALLENGE COMPETITIONS

In the context of the societal challenges, certain subject areas that strongly focus on precise objectives warrant competition by teams that are working on competing approaches. These Challenge Competitions will allow for the selection and funding of a number of teams who will be asked to facilitate head to head comparisons of their respective approaches via a series of tests. Various Challenge Competitions are planned for 2015; each will be subject to a specific call for proposals that will define the competition’s objectives and the types of envisaged tests. The launch of a given Challenge Competition may be preceded by a preparatory workshop, for purposes of defining the scope and organisational modalities for the competition. Coordination of this workshop will itself be subject to a specific call for proposals. We recommend that you consult the 2015 calendar on the ANR website.

Three Challenge Competitions are planned, as at the date of publication of the Work Programme 2015 (for detailed information on these competitions, see the relevant societal challenges):

- The **VIVIANES** (Intelligent Vehicles in the City - Independent Navigation and Safety) Challenge Competition: at the interface of challenges 6 and 7 (see section D-6 or D-7)
- The **DEFALS** (detection of falsifications in images and videos) Challenge Competition: at the interface of challenges 7 and 9 (see section D-7 or D-9)
- The **RoMI** Challenge Competition (robots and intelligent machines): at the interface of challenges 3 and 7 (see section D-3 or D-7)

“At the frontiers of research” component

E-2) OH Risk

Objectives

Fostering creativity, daring and risk taking for projects with high scientific potential is one of the priorities of the France-Europe 2020 Strategy. These objectives occur throughout the ANR’s 2015 Work Programme and will be one of the selection criteria for all funding instruments.

However, there is one category for very high-risk (albeit high-potential) projects that requires a dedicated instrument and has very special selection criteria. These are projects involving preliminary research necessary to demonstrate the feasibility of a new concept or to develop a research area for which there is no real precedent in the scientific literature. Funding for this proof of concept category is indispensable when it comes to getting audacious research projects off the ground that break with traditional approaches. These are seed projects which, by their very nature, do not lend themselves to selection based on traditional criteria of scientific excellence.

Submission, evaluation, selection

The selection process revolves around a single submission document that describes the proposed idea, explains why there is no real prior work to validate it and, the likely level of impact in terms of breakthroughs in scientific knowledge, technological developments and/or potential economic benefits.

The programme will take the form of a contest, based on very specific criteria and procedures aimed at selecting a small number of proposals. The procedures and timelines are available on the ANR website.

“Economic impact and competitiveness” component

One of the French National Research Agency’s main aims is to promote the transfer of the outcomes of public funded research to industry. In addition to collaborative public-private partnership projects (see section B-12 – Collaborative research projects involving enterprises), which constitute the main instrument of the generic call for proposals in regard to industry, the ANR provides a series of programmes aimed at strengthening partnerships between research laboratories and private companies according to various project research methods.

This cross-cutting component combines three programmes that fall within the scope of specific calls for proposals:

- LabCom
- Industrial chairs
- Carnot Institutes

E-3) LABCOM

Objectives

The programme to support the creation of research laboratories shared by public research bodies and SMEs/ or intermediate-size companies aims to develop the potential for industrial partnerships and transfer in academic research, particularly in research activities not under partnership. The aim of this programme is to help these researchers to establish lasting bilateral partnerships with companies, especially SMEs, since such partnerships are crucial to the innovation process. The transfer of outcomes or knowledge from government funded research to this type of company can be a robust driver of innovation, competitiveness and employment.

Submission, evaluation, selection

For this programme, which began in 2013, the ANR has taken the measures necessary for rapid decision making and funding availability. The Agency has developed a streamlined peer selection process, based on a single panel, without mandatory use of external peer reviewers. This selection process is based on a simplified application and lump sum funding of €300,000 from the public research laboratory, so as to expedite application processing and allow for more rapid funding and greater flexibility in the use of the research grant.

Funding procedure

This programme is subject to a specific call for proposals, whereby applications will be accepted on a continuous flow basis. We recommend that you consult the relevant page³² on the ANR webpage.

E-4) INDUSTRIAL CHAIRS

Objectives

The aim of this programme is threefold:

1. For public and private researchers involved in the Chair to conduct research in strategic priority areas via a strong and lasting partnership
2. To provide training through the quest for quality by making the vision, methodologies and experience of private players available to doctoral or post-doctoral researchers in high-level public research laboratories
3. To help higher education and research institutions or public research organisations host eminent French (expatriates or otherwise) researchers or foreign professors

This programme involves a call for proposals in all research areas on topics defined from the outset by the public research laboratory/laboratories together with their private sector partner/partners. The project will be led by an eminent scientist (future holder of the Chair), will unfold in one or more public research laboratories, and will be jointly funded by the ANR and the relevant company or companies.

Submission, evaluation, selection

The selection process will be based on a single application document submitted by the host institution in close collaboration with the relevant companies (which will be required to submit a letter of commitment upon submission of the programme), along with the CV of the envisaged holder of the industrial chair.

The evaluation will be based on the following evaluation criteria: excellence of the candidate; strategic level of the research programme; the extent to which the project's budget and expertise are consistent with its goals; governance quality; resources allocated by the project to training; procedures that will be instituted to promote the emergence of breakthrough projects; PI

³² <http://www.agence-nationale-recherche.fr/financer-votre-projet/impact-de-la-recherche-et-competitivite/laboratoires-communs/>

management and operational procedures; hosting conditions for the holder; measures that will be instituted to secure the future of the industrial chair.

Funding will be provided for up to 48 months. The ANR funding will be provided in conjunction with that of the private companies (capital) and will be disbursed to the host institution.

Funding procedure

This initiative is subject to a specific call for proposals. Researchers are advised to consult the calendar of 2015 calls for proposals on the ANR website.

E-5) CARNOT INSTITUTES

Since 2006, Carnot funding has been granted by the Ministry of Higher Education and Research to public research institutions qualified as "Carnot Institutes" that make research partnerships their main strategic focus. In the interest of promoting and supporting cooperation between research institutions and private stakeholders, the ANR makes an annual contribution (based on partnership revenues) to the Carnot institutes. This contribution is used to develop scientific resources and for the professionalisation of partnerships with industry.

To guarantee the success of the Carnot programme and ensure effective leverage, the programme has an allocated budget under the Investments for the Future programme. Two calls for proposals have been launched in this framework, one for specific initiatives related to SMEs and the other for specific international initiatives.

A new upcoming call for proposals will allow the available funding instruments to be more in sync with the needs of the relevant economic sectors, and will in particular promote greater funding for SMEs.

E-6) ASTRID AND ASTRID MATURATION

The ASTRID (French acronym for "specific support for defence research and innovation") and ASTRID Maturation programmes are entirely financed by the French Defence Procurement Agency (DGA) and are subject to specific calls for proposals that are under the ANR management. We recommend that you consult the calendar of these calls for proposals on the ANR website.

- The ASTRID programme aims to promote the development of new avenues of research in two fields: investigations of scientific or technical sticking points; and promoting technological breakthroughs that could potentially be beneficial for defence purposes, and for civilian and industrial research.
- The ASTRID-Maturation programme promotes the application of scientific research carried out via other dual-use research funding instruments, and the ASTRID programme in particular.

The cross-cutting dimensions of the ASTRID programmes constitute a broad scientific field encompassing key domains of dual-use research.

“Building the European Research Area and France’s international attractiveness” component

Apart from international collaborative research projects (PRCI; see section B-1-3), which are the main bilateral collaborative instrument for the ANR’s generic call for proposals, other types of European and international measures are planned in connection with the Building the European Research Area (ERA) and international attractiveness component of the Work Programme 2015:

- Setting up European or international scientific networks (**MRSEI**)
- Hosting High-Level Researchers (**@RACTION**)
- **European and international calls for proposals** (ERA-NETs, JPIs, bi- or multilateral calls for proposals (see section F)

E-7) SETTING UP EUROPEAN OR INTERNATIONAL NETWORKS (MRSEI)

Objectives

The MRSEI programme aims at facilitating French researchers' access to the European (Horizon 2020 in particular) and international funding programmes.. Hence, submission of such proposals will need to be followed by submission of a proposal for European or international calls for proposals.

Responding to the MRSEI instrument will entail the creation of a scientific network of the highest level, selecting subjects of strategic importance, and defining envisaged actions that will have a major impact at the scientific, technological or societal level. We are looking for projects that will strengthen France’s scientific leadership, which ideally will take the form of French coordination of a proposal submitted in response to a large scale European or international call for proposals.

Candidacy modes

The *MRSEI* programme will be subject to two or three specific calls for proposals annually. We recommend that you consult the relevant page on the ANR website.

Evaluation, selection, funding

For the MRSEI programme, the French National Research Agency has taken the measures necessary for rapid decision making and funding availability: (i) simplified application; (ii) the public research laboratory acting as the principle project investigator will be the single beneficiary of the grant for the account of the consortium as a whole; (iii) peer selection by a single ad hoc evaluation panel without mandatory use of external peer reviewers.

The characteristics of this funding instrument are as follows:

ANR funding: around €30,000. Consortium: one or more French partners, and European or international partners. Funding: a single funded partner (from France). Research type: technical feasibility studies. Duration: 6 to 12 months.

E-8) HOSTING HIGH-LEVEL RESEARCHERS (@RACTION)

The *Hosting High Level Researchers* instrument (@RACTION), which is subject to a specific call for proposals, aims to bolster the international attractiveness of the French research system. The capacity to host high level researchers from abroad in French laboratories for a substantial period of time is an important factor for France' scientific positioning at international level. The goal here is to facilitate such hosting, by offering top scientists substantial resources that will enable them to reside in France for a considerable period. This programme is intended for junior researchers with high potential (including following a post-doctoral position abroad) and high level researchers with a solid track record.

This instrument provides researchers with substantial funding to allow them to form a team and carry out a new ambitious project that is expected to have a major impact. Such funding is contingent upon a major commitment from the host research institution (university or the like).

The scientific coordinators of the project may be foreign or French. He/ She must have spent a considerable amount of time doing research outside of France, depending on his/ her profile in question. For example, a candidate wishing to come to France following a post-doctoral position abroad should ideally have stayed in that position for at least a year, having thus been able to demonstrate his/ her potential. An experienced candidate, on the other hand, should ideally have spent a major part of his/ her scientific career abroad. Scientific coordinators should be in a position to quickly establish themselves in France after having received the ANR grant.

The characteristics of this funding instrument are as follows:

ANR funding (indicative figure only): €150,000 to €900,000. Consortium: a single research institution partner. Type of research: basic; industrial; experimental development. Duration: 36 to 48 months.

F. European and international collaborations under the Work Programme 2015

The French National Research Agency partners with foreign research funding agencies and concludes agreements with them allowing for collaborations by teams from various countries. Each agency finances its own country's team in such cases.

Such agreements may concern specific topic areas, or may encompass all of the research areas financed by the ANR. These agreements are carried out under the ANR's generic call for proposals, or through the issuance of specific European or international calls for proposals.

An advisory board specifically for the *Building of the ERA and France's international attractiveness* component was established in late 2013 at the ANR. This committee advises the Agency on implementation of a consistent international partnership strategy in the Agency's field of endeavour, and recommends future directions for ANR actions.

The main bilateral collaborations planned for 2015 under the generic call for proposals, as well as the interplay between the Work Programme 2015 and specific European and international calls for proposals, are summarised below. This interplay between French and European and international programmes will unfold on the basis of a multi-year activity prioritisation plan.

Please note that these lists of partnerships and calls for proposals are provisional and may be subject to change. It is advisable to check the generic call for proposals web page and the calendar for the specific calls for proposals, both of which are updated regularly on the ANR website.

F-1) BILATERAL PARTNERSHIPS UNDER THE GENERIC CALL FOR PROPOSALS

The French National Research Agency has entered into partnerships with counterpart European agencies (Germany, Austria, Switzerland, etc.) and elsewhere (Canada, Brazil, China, Singapore, Taiwan, Hong Kong, India, etc.). The objectives of these partnerships are as follows:

- Speeding up and developing collaborations by French researchers with the top European and international research teams in key fields of research
- Fostering partnerships that can potentially yield shared benefits, with emerging countries on topics of mutual interest
- Promoting the formation of top notch international teams that will allow for the realisation and sharing of top drawer research world-wide

For partnerships centring around specific fields of research, the ANR and its partners plan to continue the theme over a two to three year period, in order to strengthen the collaborations and promote the realisation of quality projects.

These partnerships are set up through of the mutual opening of national calls for proposals in each country, a bilateral collaboration in which proposals are submitted to and evaluated in parallel by each agency. The agencies then collaboratively decide which projects to co-fund. These transnational projects compete with national projects that are in the evaluation phase. For 2015, this type of project will be submitted to the ANR's generic call for proposals, using the PRCI instrument (see section B-1-3). It is absolutely essential to consult the country specific annexes containing

information on the conditions and thematic or disciplinary fields that come into play for these bilateral partnerships.

A lead agency agreement is concluded with some agencies. This type of agreement is based on transparency and mutual trust; its use is a gauge of the ERA's construction. Thus, a joint proposal is prepared by the teams and is submitted to the lead agency, which is responsible for peer reviews, evaluation and project selection. These transnational projects compete with national projects submitted to the agency conducting the evaluation. The partner agency has access to all information. Each agency finances its country's teams according to its own conditions.

For 2015, the French National Research Agency will be receiving and evaluating applications on behalf of funding agencies in Germany (DFG), Switzerland (SNSF), Austria (FWF), and Brazil (FAPESP). Candidates are required to indicate in their application that they have opted for the PRCI instrument of the generic call for proposals. It is absolutely essential to consult the country specific annexes containing the application procedure that comes into play for these bilateral partnerships.

[See table 1:](#) Bilateral collaborations under the generic call for proposals 2015

F-2) SPECIFIC EUROPEAN AND INTERNATIONAL CALLS FOR PROPOSALS

In connection with the various societal challenges, the French National Research Agency has entered into multilateral partnerships with its European counterparts for European initiatives such as ERA-NETs, ERA-NETs COFUND, and Joint Programming Initiatives (JPIs). These initiatives complement those carried out under the European Horizon 2020 framework programme. In line with this concept, emphasis is placed on multi-year prioritisation of European activities and the interplay between national and European tools. The manner in which these programmes complement each other is hammered out sector by sector for the long term. ERA-NETs, ERA-NETs COFUND and JPIs activities are subject to specific calls for proposals. It is advisable to consult the calendar of specific calls for proposals on the ANR website.

Similarly, several international agreements with major foreign funding agencies have been concluded, either under bilateral partnerships (NSF in the US, JST in Japan, BMBF and DFG in Germany) or under multilateral partnerships on a global scale (G8-HORCs or Belmont Forum). These initiatives will result in specific calls for proposals. We recommend that you consult the calendar of these calls for proposals on the ANR website.

[See table 2:](#) Specific European or international calls for proposals lying outside the scope of the generic call for proposals 2015

Table 1: Bilateral collaborations under the generic call for proposals 2015

Countries (agencies)	Collaborative topic areas proposed by the ANR in 2015 that are subject to confirmation, pending acceptance by the foreign agency in question	Relevant challenges
Brazil (FAPESP; FACEPE)	Neurosciences, CVD and metabolism Marine research Humanities and social sciences	Challenges 1, 4, 5, 8 All-Knowledge challenge
Canada (NSERC)	SPG Programme All disciplinary fields apart from SSH and health/biology	Challenges 2, 3, 5, 6, 7 All-Knowledge challenge
India (DST)	Neuroscience Engineering sciences (sub-domains: material sciences, chemistry, intelligent transportation systems, energy)	Challenges 2, 3, 4, 6, 7 All-Knowledge challenge
Turkey (TUBITAK)	Marine geosciences Seismic risks Mechanisms of marine ecosystems Humanities and social sciences	Challenges 1, 5, 8; All-Knowledge challenge
China (NSFC)	Water security, catchment basin management, remediation	Challenges 1, 4, 7 All-Knowledge challenge
Singapore (NRF)	Materials, nanotechnologies, nanosystems	Challenges 2, 3, 7 All-Knowledge challenge
Taiwan (NFC)	All disciplinary fields financed by the French National Research Agency and the Taiwanese agency	Challenges 1, 2, 3, 4, 5, 6, 7, 8 All-Knowledge challenge
Hong Kong (RGC)	All disciplinary fields financed by the French National Research Agency and the Hong Kong agency	Challenges 1, 2, 3, 4, 5, 6, 7, 8 All-Knowledge challenge
Europe		
Germany (DFG)	All disciplinary fields financed by the French National Research Agency and the German agency	All challenges
Austria (FWF)	All disciplinary fields financed by the French National Research Agency and the Austrian agency	All challenges
Switzerland (SNSF)	All disciplinary fields financed by the French National Research Agency and the Swiss agency	All challenges

Table 2: Specific European and international calls for proposals lying outside the scope of the generic call for proposals 2015

Specific calls for proposals	Relevant challenges	Timing
Belmont Forum, collaborative research measures: observation of the Arctic and research on sustainability	Challenge 1	Closing date 31 July 2014
Belmont Forum, collaborative research measures: biodiversity scenarios and ecosystem services (phase 1)	Challenge 1	Closed
JPI Oceans: contamination of the food chain by microplastics	Challenge 1	Subject to agreement
JPI Climate + Belmont Forum: climate predictability	Challenge 1	Subject to agreement
France-Japan/ANR-JST call: molecular technologies for functionalised materials	Challenges 2, 3, 4, and 7	Subject to agreement
ERANET-MED: renewable energy and water management in Mediterranean countries	Challenges 2 and 5	Subject to agreement
France – USA/ANR-NSF call: PIRE programme: energy, advanced manufacturing, social sciences	Challenges 2, 3 and 8	Subject to agreement
ERA-NET M-ERA.NET: material modelling and engineering	Challenge 3	Closed
ERA-NET ERASynBio: synthetic biology	Challenge 4	Subject to agreement
JPI HDHL “Healthy diet healthy life”	Challenges 4 and 5	Subject to agreement
France – USA/ANR-NSF call: computational neurosciences (CRCNS programme)	Challenges 4 and 7	Subject to agreement
ERA-NET Infect-ERA: infectious human diseases	Challenge 4	Subject to agreement
ERANET EuroNanoMed 2: nanomedicine	Challenge 4	Subject to agreement
ERA-NET ANIHWA: animal health and well being	Challenges 4 and 5	Subject to agreement
France-Germany-Canada-Quebec/ANR-BMBF-CIHR-FRQS call: epigenomics	Challenge 4	Subject to agreement
ERA-NET COFUND: E-Rare 3: rare diseases	Challenge 4	Subject to agreement
ERA-NET COFUND EraCoSysMed: systems medicine	Challenge 4	Subject to agreement
ERA-NET COFUND, in support of JPND calls for projects on neuro-degenerative diseases	Challenge 4	Subject to agreement
ERA-NET Neuron 2: neurosciences	Challenge 4	Subject to agreement
JPI AMR: resistance to antimicrobial agents	Challenge 4	Subject to agreement
ERA-NET FLAG-ERA: (Graphene and Human Brain Project)	Challenges 6 and 7	Subject to agreement
ERA-NET ARIMNET 2: agriculture, agro-food and resource management in Mediterranean countries	Challenge 5	Subject to agreement
Plant KBBE: yield from cultivated plants, and food safety in the face of climate change	Challenge 5	Subject to agreement
JPI FACCE ERANET COFUND: sustainable agriculture for biomass production for food and non-food purposes	Challenge 5	Subject to agreement
ERA-NET COFASP: sustainable fishery exploitation	Challenge 5	Subject to agreement
ERA-NET CHIST-ERA2: reliable and resilient cyber-physical systems; understanding human language	Challenge 7	Subject to agreement
France-Germany-Japan/ANR-DFG-JST call: SPPEXA – big data and extensive exaflop calculations	Challenge 7	Subject to agreement
BDEC: big data and high performance calculations concerning large scale problems	Challenge 7	Subject to agreement
France-Germany/ANR-DFG call: Social sciences and humanities	Challenge 8, All-Knowledge challenge	Subject to agreement
France-Germany-UK-The Netherlands/ANR-DFG-ESRC-NWO call: Open Research Area (ORA) SSH	Challenge 8	Subject to agreement
JPI CHGC ERA-NET + Heritage Plus: cultural heritage	Challenge 8	Closed