

# 2014 Work Programme

## Generic Call for Proposals

Opening of the 2014 Generic Call for Proposals: 31 July 2013

Deadline for submission of pre-proposals: 23 October 2013,  
13.00 (Paris time)

# The ANR 2014 Work Programme

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# 1 Context and objectives

## 1.1 Introduction

The main mission of ANR, the French National Research Agency, is to fund the best basic research, but also targeted and applied research in particular through partnerships between companies and public sector laboratories. Its action is thus intended to support French research excellence at both academic and technological levels by means of a rigorous selection process based on evaluation by peer review. Finally, it is also the ANR's mission to strengthen international cooperation by contributing in particular to the funding of international consortia in partnership with other funding agencies in Europe and beyond.

The ANR 2014 Work Programme, adopted on 26 July 2013 by its Governing Board, comes under the framework fixed by the "France Europe 2020" Strategic Agenda presented by the Minister for Higher Education and Research on 21 May this year. It reformulates all of the ANR's actions and clarifies its main methods of intervention. The 2014 Work Programme is a single consolidated document, adopted by the ANR's Governing Board. It describes the essential elements of the initiatives and calls for proposals issued by the ANR for the financial year 2014. This document replaces the programme planning document and most calls for proposals as issued in previous programme plans.

The 2014 Work Programme is addressed to all scientific communities and all public or private players involved in French research and in particular SMEs and very small enterprises (VSEs).

It includes elements of definition of the major scientific and thematic fields for which the calls for proposals are issued, description of the various funding instruments and lastly the procedures for evaluating proposals.

## 1.2 Structure of the 2014 framework programme

A large part of the 2014 framework programme is treated as a **single generic call for proposals** meaning that the number of calls for proposals is significantly reduced and the funding offer is made clearer.

**The selection procedure for this generic call for proposals will proceed in two stages** (cf. section 7).

In addition to its own intervention budget, the ANR has concluded partnerships with other research funding agencies (the DGA French Defence Procurement Agency, DGOS General Directorate for Care Provision, CNSA National Solidarity Fund for Autonomy, FRAE Research Foundation for Aeronautics and Space, etc.) for issues coming under major societal challenges.

Other more targeted calls for proposals will also be issued in the context of financial year 2014 (the ASTRID programme funded by the DGA, calls for proposals coming under ERA-NET initiatives, Joint Programming Initiatives (JPIs), and bi- or multi-lateral calls for proposals with foreign agencies). These calls will be subject to specific procedures and we recommend that you consult the calendar relative to their publication on the ANR website.

The 2014 framework programme is divided into **four components** which are subject to specific budget allocation.

## 1. Major societal challenges

The Ministry for Higher Education and Research, MESR, asked the ANR to organise a large part of its 2014 Work Programme around 9 major societal challenges identified in the France-Europe 2020 Strategic Agenda<sup>1</sup>, itself consistent with the structure of the next European Horizon 2020 framework programme:

1. Efficient resource management and adaptation to climate change
2. Clean, secure and efficient energy
3. Industrial renewal
4. 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

The "major societal challenges" component is the subject of a single call for proposals, where the scientific and thematic fields are consistent with the National Research Strategy and integrate in particular the priorities expressed by the thematic research Alliances, the CNRS and the ministries concerned. This component is open to a very broad range of proposals from basic research through to applied research. The evaluation and peer review procedures for the proposals will take account of these research types. A number of scientific priorities are common to the different societal challenges. They are however only detailed once.

This division into major research fields incorporates both basic knowledge-based research projects, previously supported by the non-thematic programmes (the "Blanc" and Young Researchers programmes), and targeted research projects, often applied, which were essentially covered by the thematic programmes.

## 2. At the frontiers of research

This component is principally open through an "**all-knowledge challenge**" the objective of which is to complete disciplinary coverage for project funding. In particular it aims to support basic disciplines and essentially knowledge-based research projects without any direct link with the fields covered by the major societal challenges. In addition, a programme designed to promote the emergence of high scientific risk research projects will be put in place.

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

This component cuts across the other Work Programme components, but also includes specific instruments designed to strengthen France's international attractiveness. A European and international steering committee will be put in place to coordinate actions, take a holistic overview and design a cohesive strategy for international partnership.

## 4. Economic impact of research and competitiveness

Projects conducted as public-private partnerships are one of the main funding instruments for the "societal challenges" having a direct impact in economic terms and in terms of competitiveness.

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<sup>1</sup>[http://cache.media.enseignementsup-recherche.gouv.fr/file/France-Europe\\_2020/21/7/AgendaStrategique\\_252217.pdf](http://cache.media.enseignementsup-recherche.gouv.fr/file/France-Europe_2020/21/7/AgendaStrategique_252217.pdf)

In addition, the purpose of this dedicated component is to promote partnerships with companies and the transfer of public research results outside of conventional collaborations developed in the form of partnership projects. This component which is under single governance incorporates three programmes: LabCom, Industrial chairs and Carnot institutes.

## 2 Diverse modes of action

The ANR's 2014 framework programme offers researchers - depending on their scientific goals and their needs - various funding instruments either dedicated or common to the four components of the Work programme described above.

The funding instruments come under three categories, the rationale and characteristics of which are of key importance in the selection and monitoring of the relevant projects:

- The "**Cooperative research**" category corresponds to research work defined on the basis of a description of the objectives to be attained within a framework of limited resources and time period. Three funding instruments are offered: **collaborative projects, public-private partnership projects** and "**Challenge competitions**";
- The "**Researcher**" category corresponds 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 advance the scientific influence of the laboratories they work in. Three instruments are offered: "**Young researchers**", "**Hosting high level researchers**" and "**Industrial chairs**";
- The "**kick-start**" category corresponds to funding over a short time period for structuring activities by a scientific community performed upstream of large-scale research work. A new instrument is offered: **research networks**.

### 2.1 Dedicated funding instruments for "cooperative research"

#### 2.1.1 Collaborative projects

This has been the main ANR funding instrument until now. Collaborative projects aim to achieve results through the pooling of the skills and resources of different research teams. The funding granted, by enabling collaborative work, thus accelerates proposed research projects. This instrument encourages research teams to work on projects for which collaboration provides added scientific value, either because it makes the work possible, or because it enables the possibility of more ambitious or higher quality results. Proposals for multidisciplinary research work are welcome in this instrument category.

- Indicative ANR funding level: €100 to 500 k
- Consortium: at least two research bodies which are operational structures<sup>2</sup>
- Research category<sup>3</sup>: mainly basic research, but also industrial research and experimental development
- Duration: 24 to 48 months

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<sup>2</sup> Cf. definition in the 2014 funding regulations

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### 2.1.2 Public-private partnership collaborative projects

Collaborative projects conducted as partnerships between public research laboratories and companies aim to jointly achieve research results that will be advantageous to both parties, by enabling public laboratories 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 ultimately improve their innovation capacities. They also serve to increase the transfer of results and know-how from public research to the industry.

- Indicative ANR funding level: €200 to 800 k
- Consortium: at least one research body partner and at least one enterprise
- Research category: basic research, industrial research, experimental development
- Duration: 24 to 48 months

### 2.1.3 International projects

The strengthening of international collaborations is one of the ANR's missions.

The "International projects" instrument aims to promote collaborative research across Europe and with other partner countries. It includes both collaborative projects and public-private partnership collaborative projects where there is at least one French partner and at least one foreign partner. The ANR provides funding only for the French partner(s). This instrument is in part based on multilateral or bilateral, European or international calls for proposals.

In the framework of the generic call for proposals covering the "Major societal challenges" and the "All-knowledge challenge", international projects necessarily entail at least one foreign partner requesting grants from a foreign funding agency in the framework of a bilateral or multilateral agreement between the ANR and other foreign funding agencies (see § 5.1). Selection of the project is then subject to an agreement by the two funding agencies. It is important to consult the additional terms and conditions published for each country.

- Indicative ANR funding level: €100 to 800 k
- Consortium: at least one French research organisation and one foreign partner
- Research category: mainly basic research, but also industrial research and experimental development
- Duration: 24 to 48 months

In the case of proposals with foreign partner(s) providing its/their own funding or through national funding obtained outside bilateral agreements between the ANR and a foreign funding agency, the pre-proposal is to be submitted to the ANR alone and outside the framework of the international calls for proposals, simply providing evidence of the foreign partner's/partners' financial means.

### 2.1.4 "Challenge competitions"

In the context of the societal challenges, certain subject areas very much focused on precise objectives warrant competition by competing teams. The "Challenge competitions" launched by the ANR encourage several teams to work on the same issue, enabling them to put forward their respective approaches on a scientific application or matter. A number of competitions linked to the

societal challenges will be initiated in 2014. The competition subject area, the possible approaches and competition procedures will be the subject of specific calls for proposals. We recommend that you consult the 2014 calendar on the agency's website.

## 2.2 Funding instruments targeting individuals

### 2.2.1 Young Researchers

The objective of the "Young Researchers" instrument is to prepare a new generation of talented young researchers who are likely to become the future leaders and directors of French scientific research. Its aim is to encourage young researchers to take responsibility, and to prompt them to tackle scientific or technological hurdles, adopting original approaches.

Therefore the instrument aims to promote young researchers empowerment and their acquisition of a project mode culture, while enabling them to develop their own research theme 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 initial ANR grant, will thereon find it easier to envisage submitting a project in response to ERC calls for proposals, and with improved chances of success.

- Indicative ANR funding level: €100 to 400 k
- Consortium: a single research body type partner, the scientific coordinator having been awarded his/her doctorate less than 10 years from the publication date of this Work Programme.
- Research category: mainly basic research, but also industrial research
- Duration: 24 to 48 months

### 2.2.2 Hosting high level researchers

The "Hosting high level researchers" instrument aims to bolster the international attractiveness of the French research system. It is managed under the "Building the European Research Area and France's international attractiveness" component and is the subject of a specific call for proposals.

The capacity to host, for a long period of time, high level researchers from abroad in our country's laboratories is an important factor for France' scientific positioning at international level. We wish to promote this hosting policy through funding which will offer the best of these scientists significant means so that they can settle in France over a long period. This programme is intended for both junior researchers with very good potential (including following a post-doctoral position abroad) and high level senior researchers.

The objective of the instrument is, along with a strong commitment by the hosting research body (Public scientific and technical research establishment or EPST, a university, etc.), to provide the researcher with substantial means to enable him/her to set up a team and conduct a first ambitious project which has anticipated significant impact.



The scientific coordinators may be foreign or French. They must have had a significant period of scientific activity abroad depending on the profile. For information, candidates wishing to come to France following a post-doctoral position abroad should have stayed for at least one year enabling them to clearly show their potential, whilst senior candidates should have spent a major part of their scientific career abroad. Scientific coordinators should be in a position to quickly establish themselves in France following an ANR funding provision.

This instrument largely covers the former Post-doctoral Return and Chairs of Excellence actions. It will be coordinated with the INSERM/CNRS Atip Avenir programme.

- Indicative ANR funding level: €150 to 900 k
- Consortium: a single research organisation partner
- Research category: basic research, industrial research, experimental development
- Duration: 36 to 48 months

## 2.3 Dedicated funding instruments for kick-starts

### 2.3.1 Research networks

The setting up of certain large-scale research projects cannot be achieved easily using existing structures, either because the envisaged research community has not yet been created and requires foresight thinking, or because the problems to be solved have to be formulated by an especially broad community.

This instrument aims to fund collective study by French and foreign laboratories, companies, institutions and associations. ANR's funding goal is to arrive at the definition and structuring of an ambitious research programme or research strategy, in particular at European level, or at international level.

Proposals selected must enable strengthening of France's participation in the definition of international scientific agendas. This implies the construction of a scientific network of the highest level, a selection of subjects of strategic importance and the definition of actions to be carried out which will have a major impact at the scientific, technological or societal level.

The anticipated result is consequently a strengthening of France's scientific leadership, to be expressed in particular in terms of coordination of international projects. Particular attention will therefore be paid to research networks whose objective it is to submit a proposal in response to a large-scale European or international call for proposals.

- Indicative ANR funding level: €50 k (approx.)
- Consortium: a single funded partner of the research organisation type, broad partnership
- Research category: technical feasibility studies
- Duration: 12 to 24 months

## 3 The "Major Societal Challenges" component

This component organised in 9 societal challenges represents the largest part of the ANR's intervention budget. These societal challenges cover both basic and applied research. They require both basic knowledge-based research and targeted research approaches in a number of high-stake priority thematic areas. For the most part, the societal challenges necessitate building on multidisciplinary or interdisciplinary research work. For each challenge, a box contains information on the scientific fields and programmes previously supported by the ANR.

**This component is the subject of a single generic call for proposals.**

Optimisation of public research funding is imperative. The thematic areas supported under the 2014 Work Programme shall in particular focus on complementing thematic areas that are not the subject of funding opened under the European Commission's Horizon 2020 framework programme. The same applies to thematic areas supported either in the framework of European or international actions (ERA-NETs, JPIs, multilateral calls), or at national level by other public funding bodies (specific national plans, calls by ministries, ADEME, ANSES, ANRS, INCA, ONEMA, etc.). These elements will be taken into account when evaluating the pre-proposals.

### 3.1 Efficient resource management and adaptation to climate change

Since changes in Neolithic times, with the development of agriculture, livestock farming and urbanisation, the environment has been profoundly shaped by man. In a world of over 7 billion people, with constantly changing needs (energy, materials, products, services, etc.) and practices (lifestyle, mobility, culture, etc.), environmental changes (climate change, erosion of biodiversity, degradation of soil and water resources, chemical pollution of air and water, etc.) are today such that they are noticeable at both local and global planet level. It is estimated that costs associated with climate and environmental change could exceed 5% of GDP in 2030 if appropriate adaptation and remediation policies are not put in place in time. This new era, termed the Anthropocene era, poses the complex problem of integrated management, including on a worldwide scale, of environments and development trajectories of human societies in all their diversity.

This societal challenge necessitates developing knowledge, on the one hand, about the processes at the origin of interlinked environmental changes, including climate change, how they evolve, their actions, interactions and feedbacks, and on the other hand, about their local or regional consequences for human activities, in particular those that rely on ecosystem services and sensitive components which are natural water resources, soil, biodiversity. It also necessitates greater knowledge relating to remediation of these environments, and exploitation of sustainable and environment-friendly raw materials. Lastly, this challenge is also one of ecological transition, from local to global level, and the knowledge we need to be able to adapt to the changes and seize alternative development opportunities, in a global context with high cultural diversity where socio-economic viability, respect for the environment, justice and equity cannot be considered separately.

A great number of issues in environmental research today require multidisciplinary approaches within broad disciplinary fields or between distant disciplines. Finally, the science-society dialogue needs to be strengthened so that research priorities can be jointly identified and jointly constructed

by integrating the knowledge and needs of research users at the environment/development interface. Proposals should therefore include in their partnership, decision makers or stakeholders from the civil society, from the public or private sector.

Numerous scientific disciplines are sought in order to respond to the challenges involved: social sciences and humanities, environmental sciences, life and earth sciences, engineering sciences, but also, in certain cases, applied mathematics and information and communication sciences.

The research themes are presented below. The envisaged proposals may relate to one or more themes or sub-themes, depending on the various ANR instruments that may be utilised in a national, European or international context.

This societal challenge incorporates a good number of scientific fields previously supported by the blue-sky "Blanc" programme (SHS1, SHS2, SHS3, SIMI1, SIMI2, SIMI3, SIMI6 SIMI9, SVSE6, SVSE7) and by thematic programmes (Environment & Societies, Ecotechnologies & EcoServices, and part of BioAdapt).

### 3.1.1 **Research theme: Understanding and anticipating environment changes**

In order to evaluate and predict environmental, global and multi-factor changes, it is necessary to consolidate our knowledge base on the dynamic, physical-chemical and biological processes of the Earth System's different sub-systems. These sub-systems are in constant interaction and the issues presented below are therefore clearly interconnected.

- **Functioning of climate, oceans and major cycles**

The subject 'climate' touches on all the Earth System's sub-systems: the atmosphere and the hydrosphere, including oceans and the cryosphere, in close interaction with the geosphere, the biosphere and human societies. Numerous knowledge gaps need to be filled for better understanding and representation of processes and to reduce bias and uncertainties in models (for example, physical-chemical aerosol-cloud interactions, water mass subduction in oceans, marine biogeochemistry, turbulence, scale and space overlap and interaction, interface zones between environmental compartment, water, carbon and nitrogen cycles, etc.). Global warming, chaotic and marked by extreme occurrences, leads us to ask questions about natural variability and separating natural and anthropogenic signals (emission of gas and substances). Use of proxies and historical records is encouraged on recent millennia, or on past periods of rapid transition producing glacier surges in Greenland and/or the Antarctic, to shed light on our interpretation of the variabilities and trends in this current century. Over recent decades or recent centuries, participation in or exploitation of major global re-analyses of the Earth System is encouraged for a better understanding of regional modes of variability and associated extremes, in oceans, the cryosphere and the atmosphere.

- **Functioning of the critical zone (water cycle, soils and subsoils)**

The multifunctional character of the critical zone linking soils, subsoils, water and biogeochemical cycles constitutes a central question for numerous properties of [agro-]ecosystems with issues relative to the provision of both market goods and non-market services (climate regulation, water, greenhouse gases, mineral or biogeochemical elements, biodiversity conservation, etc.), which retroactively affect, including on a global scale, the functioning of the Earth System.

In the field of water, numerous scientific questions remain open: a better understanding of the dynamics in soils and subsoils, assessing the quantitative and qualitative impacts of modifications to

the hydrologic regime associated with climate changes or soil degradation, creating scenarios on changes in usage and management of water resources.

With respect to soils, long term degradation (erosion, loss of chemical and biological fertility, contamination, salinization, urbanisation, etc.) is widely underestimated. It should be considered at different scales, from a parcel to a region, from decade to several centuries. Strengthening of integrated approaches is expected with multidisciplinary approaches including in particular biotechnical research and research in the fields of social sciences and humanities.

- **Functioning and adaptation of species, agroecosystems and continental and marine ecosystems**

Climate changes, increased CO<sub>2</sub> and acidification, and degradation of biodiversity are major consequences of the global change with which natural ecosystems and productive ecosystems are confronted. Understanding of the links between climate, biodiversity and agroecosystem productivity must be strengthened, so that biodiversity preservation, adaptation to climate change and support or increase of agricultural, forest or marine production are made compatible.

This requires fundamental knowledge about the development of intraspecific and interspecific populations (emergence, extinction, colonisation, invasion, etc.) in continental and marine ecosystems in relation to climate change or more generally in response to environmental changes, in particular knowledge relating to host-pathogen and host-symbiont interactions. More generally, it is necessary to estimate the capacity of a system to adapt or evolve depending on its functional biodiversity and by analysing the interactions between spatial and temporal scales or between contributory trophic levels. The application scope may cover all species, model or otherwise, wild or exploited (crops, livestock, tree species, etc.) as well as all types of natural and productive ecosystems.

Research projects are particularly encouraged on i) degradation of marine or aquatic environments with issues relative to fishery resources and stock conservation, ii) species adaptation (animals, plants and microorganisms) and adaptation of agroecosystems facing climatic and environmental changes, iii) the contribution of biodiversity to the stability, resilience and strength of ecosystems and associated services, iv) the impacts of agroecosystems and of diverse practices on environmental changes including climate change, due to compounds released into air or water.

- **Change and adaptation scenario, predictability, impacts and risks**

Change in the dynamics of the Earth System, and its climate, depends on understanding of the slow components of the system (oceans, ice-caps and permafrost, soils and subsoils, ecosystems, gas and aerosol cycles, etc.), synergic anthropogenic factors, and external causes (telluric, solar, astronomical, etc.).

In an interface area between meteorology and climatology, and at the core of societal demands on climate services, the priorities to be developed are subseasonal to seasonal prediction, and also decadal variability and predictability. This pivotal scale between seasonal prediction and climate projections for the century is crucial to the development of scenarios (IPCC). This depends on a better knowledge of the mechanisms which impart memory to fluid flows, both in the atmosphere and in the ocean whether through their own dynamic or through the intermediary of initial conditions, of chemical or biological internal change in the fluids or through interaction with terrestrial conditions.

In the field of water, numerous interlinked questions remain open: i) quantifying changes in water flows and associated elements, ii) creating scenarios for development of usage and management of water resources, iii), estimating the quantitative and qualitative impacts of hydrologic regime

changes associated with global changes, iv) evaluating the potential of large-scale deployment of innovative technologies for restoration and remediation of contaminated water resources, v) ensuring balances between various territories (rural to urban). In particular, integration of the results of climate prediction models into these questions will necessitate significant advances in matters of adequacy of scale, and disaggregation of results. The heterogeneity of water resources and aquifers should also be taken account of at different scales, via stochastic or probabilistic approaches to the hydrodynamic properties of aquifers associated with different geological contexts, or satellite derived products.

In the field of changes in terrestrial, aquatic and marine biodiversity and uses of environmental media, an initiative to create scenarios for the 21st century is expected in a European and international context (upstream research for IPBES, the equivalent of IPCC for biodiversity and associated ecosystem services). This necessitates development of an interlocking and spatialised set of models representing biodiversity and functional biodiversity. Management, validation and integration of very large data sets and standardised or heterogeneous observations, current or past, will be necessary in order to propose models or operational mechanisms.

### 3.1.2 **Research theme: Technological innovation for analysis, remediation or reduction of environmental risks**

The issues associated with strategic energy resources are addressed in the societal challenge "Clean, secure and efficient energy", section 3.2 and those associated with marine and terrestrial bio-resources are addressed in the challenge "Food security and demographic challenges ", section 3.5. The issues of recycling, the circular economy and eco-processes are addressed in the challenge "Industrial renewal", section 3.3. Lastly, the issues associated with toxicology and ecotoxicology of environmental media are addressed in challenges 4 and 5.

In this research theme, the 2014 actions focus on the following two topics:

- **Observation and information systems, from sensor to service for management of environmental crises**

Numerous areas of environmental variability remain largely under-sampled and new generation of observation and information systems, designed for long term use, need to be developed to prevent and manage environmental alerts and crises. This necessitates technological, digital, economic and methodological breakthroughs.

Lower measurement costs, miniaturisation, sensor autonomy and reliability, increased data flows are major issues. This is a highly diversified area for innovation involving numerous SMEs, where technology transfers, from Information and Communication Technologies or ICTs (robotics, drones, biomimetics, crowd-sourcing, big data applications, etc.), life sciences (biotechnologies) and remote sensing (spaceborne, airborne or in-situ), are particularly targeted. This concerns all environmental media: water, air and soil relative to applications in urban, industrial and agricultural environments and their biotic and abiotic components. Technological inputs from other fields such as information and communication sciences, biotechnologies, nanotechnologies, geophysics, chemistry, ecological engineering, etc., will be especially sought after.

In the area of predicting and managing environmental alerts and crises, we anticipate the development of (pre-)operational services dedicated to natural and/or anthropogenic risks and their potential synergies (pollution, toxic blooms, invasive species, allergens, flooding, coastal flooding, ground movement, volcanic eruptions, fire, storm, drought, heat waves, water overexploitation,

etc.). The evaluation and modelling of hazards and risk situations should also be based on appropriate safety/security approaches. We expect initiatives involving integration of data on interactions between human-society and environment (extracted in particular from observatories developing such approaches) through to mathematical approaches (deterministic or probabilistic).

In the area of prediction, we anticipate the development of (pre-)operational services relative to environment quality, the prevention of natural or anthropogenic risks, including for diagnostics, the attribution and management of extreme events. This necessitates putting in place integrated systems ranging from assimilation of heterogeneous data to prediction systems and linkage to warning systems, in liaison with key players and users concerned. Depending on the fields, predictive systems will focus on periods ranging from a few days to a few months, and on spatial zones that may range from a town, to a large region, or Europe. NB: climate services are addressed above (section 3.1.1).

- **Remediation technologies: soils, sediments, water, air**

As regards remediation, the main issues relate to restoring soil quality and restoring biodiversity in various vulnerable environments (coasts, overseas territories, surface and ground water, etc.). The intention is to move on from the concept of "strictly corrective treatment" towards the more systemic concepts of "sustainable remediation" within integrated strategies of improved recyclability (greywater, polluted water, etc.) or rehabilitation (including pollution control, redevelopment, biodiversity restoration, green and blue corridors, etc.) on the scale of a territory, a catchment area, a coastal area, a de-industrialised zone, etc. We need to go beyond empiricism and an understanding of processes, in order to build the foundation of a practices-based engineering, using and developing ecological engineering tools and new technologies derived in particular from biotechnologies, chemistry and nanotechnologies associated with ecological engineering.

In the field of water, preference will be given to proposals relating to breakthroughs in terms of designing the "waste water treatment plant of the future" integrating in particular the notion of recovery of raw materials derived from the treatment (N, P, etc.), and consideration of emerging pollutants and energy efficiency.

In terms of climate change, the programme aims to support exploratory research in the field of global climate engineering, in particular the capture of CO<sub>2</sub> from the air or ocean sequestration of CO<sub>2</sub> using physical, chemical or biological methods. Technological and economic-environmental feasibility studies are anticipated, as well as critical analyses on the induced secondary impacts or on issues of governance and interplay between stakeholders, taking account of the associated uncertainties and risks.

### 3.1.3 **Research theme: Ecological transition, societal transformation, risks and opportunities**

The issues relative to efficient resource management and adaptation to climate and environmental change, with a view to sustainable development, can only be addressed and dealt with by taking account of complex interactions between ecosystems and socio-economic systems, in other words within socio-ecosystems. Facing these challenges, the driving forces of changes in human activities (how we develop and consume, population growth, technological changes, changes in regulations, practices and social behaviours) must be examined taking account of all factors of vulnerability and of social transformation. Within this vast issue of the functioning and dynamics of socio-ecosystems, the following three major thematic areas are to be developed further:

- **Governance, social cohesion and forms of solidarity, environmental policies**

Issues of environmental management date from the invention of writing and the first urban centres having to manage local water resources, in Mesopotamia. It has now become necessary to put in place, in a consistent manner, new modes of regulation on a global, regional, territorial and local scale. The new normative modes of regulation and interconnection interact in complex way with changes in social cohesion and inter- and intra-generational forms of solidarity, in a culturally diverse world where inequalities prevail. Original approaches for understanding the processes of socio-ecological transition towards sustainable and equitable production and consumption (obstacles and opportunities, alternative strategies, factors of change, innovations, etc.) are in particular anticipated. Alternative visions, interpreting opportunities within socio-economic and political systems, and changes in associated developmental trajectories are also encouraged, as is a critical evaluation of environmental policies, ex-post and ex-ante, and associated institutional frameworks.

- **Environment, global urbanisation and migrations**

The new United Nations projections for 2050 (<http://esa.un.org/wpp>, 2012) indicate a marked slowdown in population growth with possible stabilisation of the world population at 8 to 11 billion in 2050, in a world where the level of urbanisation would rise from 50% to 75%. Regional reality is however very mixed with post-industrial nations in de-growth (Japan, Russia, etc.) where de-urbanisation problems are already apparent, whereas South Asia and Africa are in full growth with rapid and multi-faceted urbanisation.

Against this background, the study of the lifecycles of cities or megacities is an important area of research for the environment due to the multiplicity of urban typologies and diverse ecological footprints (for example, sparse in Houston or dense in Barcelona).

Furthermore, climate change transforms the ways in which we apprehend major risks and their relations with territories (in particular in vulnerable zones such as coastal areas) and poses the issue of new migrations and their consequences, in particular as regards immigration policies, policies on economic integration, and health, social and legal policies (respect for human rights).

Comparative studies, historical analyses or projections for the century are encouraged.

- **Ecosystem services, conflicts and compromises**

Ecosystem services cover multiple aspects ranging from procurement services (food, fibres, useful molecules, genetic resources, etc.) to environment regulation services (water, carbon, nutrient, trace element and metal cycles, etc.) and cultural services and amenities (spiritual, recreational, cultural aesthetic, scientific and educational benefits, etc.). Their identification, quantification and evaluation (estimate of market and non-market values) are the subject of debate and represent a rapidly growing area of research (aspects specific to bio-production and agro-food chains are dealt with in societal challenge 5). The identification and integration of stakeholders, in particular associated with mixed-use planning of terrestrial and marine territories, in the initial processes of definition of the issues and in the final phases of creating scenarios, are two crucial parameters in how these projects are conducted.

Proposals are anticipated in this field, in particular on analysis of conflicts of use between different ecosystem services (for example, biodiversity conservation versus carbon storage, energy resources versus cultural heritage, purification or buffer role versus productivity, etc.) and on emerging compromise processes between stakeholders. We also anticipate retrospective studies over several decades, or a century (for example, creation of national parks and living conditions of populations).

### 3.1.4 European and international initiatives

Research projects in the field of environmental and climate changes demand great openness with respect to Europe and internationally. This opening up is motivated by scientific thought and contributions conducted in particular in the framework of major programmes such as GEO's (Global Earth Observation) "Future Earth, Research for Global Sustainability" and international evaluations in the field of biodiversity and ecosystem services (IPBES) or climate (IPCC).

Bilateral partnerships are possible in the context of this call for proposals. You should consult the annexes by country describing the conditions and thematic or disciplinary fields concerned by these bilateral partnerships. Furthermore, European and international actions are envisaged in connection with this societal challenge in the form of specific calls for proposals (ERA-NETs, JPIs, Belmont Forum). We recommend that you consult the calendar of international calls for proposals on the agency's website.

## 3.2 Clean, secure and efficient energy

This societal challenge aims to initiate and support research projects which will contribute to encouraging the emergence of or significantly improving technologies that may have a considerable impact in the national "energy mix" and more generally at worldwide level in 2030 to 2050. It should:

- accelerate R&D efforts on the invariants of energy transition scenarios: development of renewable energy sources (solar, marine, wind, geothermal, biomass), energy system optimisation (transfers between energies and inter-conversion between energy carriers, smart grid, energy storage), effective and efficient use of energy (in buildings, cities, transport systems<sup>4</sup> and industry);
- prepare the way for technological breakthroughs with high potential impact on the energy transition (capture, storage and use of CO<sub>2</sub>, fatal heat management).

It also incorporates a better understanding of behaviours and usages, in order to develop market models and user adoption models for these new technologies.

Four main scientific objectives are targeted:

- the production of knowledge and understanding of phenomena and mechanisms, through development of theoretical models, multi-scale modelling and numerical simulations, but also experimental devices at laboratory level;
- the design of methods and procedures to be employed in future energy technologies and that will support the energy transition;
- proof-of-concept and integration into functional laboratory based devices;
- economic and social analysis of developments built around and for the user, in an individual or collective context.

In order to respond to the challenge of clean, secure and efficient energy, as part of a long-term vision, it is therefore necessary to consolidate the disciplinary competencies required and their interconnections. We must also give priority to and encourage transversal approaches, cross-fertilisation of ideas, etc., through academic collaborations but also through public-private partnerships.

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<sup>4</sup> See also the societal challenge "Mobility and sustainable urban systems"



Looking beyond the individual inputs of disciplines, energy often requires a more systemic approach and in general multi-disciplinary. This is the case for implementation of life cycle analyses, aiming among other elements to minimise demand for energy resources and rare or toxic raw materials.

Expectations for the new programming are thus geared towards this approach. Six research themes, incorporating the major scientific stumbling blocks and in particular the main proposals by the ANCRE, Allistene and Athéna alliances, constitute the grid for reading:

1. Innovative concepts for the capture and transformation of renewable energies
2. Use of the subsurface for energy purposes
3. Energy transformations and inter-conversions
4. Managing space-time variabilities relative to energies
5. Energy efficiency of processes and systems
6. Socio-economic approaches to energy use and the impact of new energy technologies

The intervention scope in the context of this societal challenge remains at a relatively upstream level of technological maturity (Technology Readiness Level 1-4), and complements other R&D funding mechanisms on projects in the field of energy, positioned on more developed phases at national level (ADEME, Investments for the future, BPIFrance) and European level (FP7 Framework Programme - Horizon 2020).

This societal challenge covers research areas which previously came under the blue-sky "Blanc" programme (SIMI5, SIMI6, SIMI7, SIMI9, SIMI10, SVSE5, SHS1 and SHS2) and mainly three programmes offered in the 2011-2013 programming cycle, SEED (Energy efficient and decarbonised systems), PROGELEC (Sustainable electricity production and management) and BIO-ME (Biomaterials and energies), but also the "Innovative societies" programme for certain social sciences related thematic areas.

Thematic areas under the VBD programme (Sustainable cities and buildings) and TDM programme (Sustainable transport and mobility) are for the most part included in the challenge "Mobility and sustainable urban systems".

It should be noted that research themes connected with nuclear energy (materials, simulation, calculation, etc.) and strategic metals come under the challenges "Industrial renewal" and "The information and communication society".

### 3.2.1 **Research theme: Innovative concepts for the capture and transformation of Renewable Energies**

Renewable energies are a major issue for the energy transition. Looking beyond conventional technologies, this field offers extensive possibilities for breakthroughs, innovations and application of new, ground-breaking concepts. Cross-disciplinary approaches (biology, chemistry, nanotechnologies, materials, etc.) constitute an avenue that will be encouraged.

#### **Solar energy**

In one hour, the sun radiates a quantity of energy onto the Earth equivalent to the world's entire annual consumption. Only 0.1% of this solar energy is used by photosynthesis and a tiny fraction for human uses. Three major modes of exploiting this energy are emerging and need to be developed by encouraging research into the interfaces and hybridisations between these areas and/or technologies, and by seeking to put in place a cohesive chain:

- direct production of electricity, through the photoelectric effect; this is a case *in fine* of improving the competitiveness of photovoltaic systems, in particular by bringing down the cost (€/kWh). Areas for improvement relate to alternatives to crystalline silicon, multi-junction solar cells, concentration, thin-film technology, organic or hybrid semiconductors, and also ultra-high efficiency concepts. Also targeted are module manufacture technologies, development of the associated electronics and conditions for "recyclability";
- heat production, low or high temperature (concentrated thermodynamic solar) that can be used to heat but also to produce electricity or hydrogen, by splitting water by means of thermochemical cycles. The use of solar thermal energy to produce cooling systems is also an avenue to be explored;
- the production of fuels, either via the natural photosynthesis route, from plant resources or photosynthetic microorganisms in which area we need a better understanding and need to improve "energy efficiencies" (production of carbohydrates, sugars, hydrogen, etc.) through genetics or synthetic biology<sup>5</sup>, or via the bio-inspired photoelectrolysis route (or artificial photosynthesis).

#### **Other renewable resources (air, water)**

Natural environments offer other renewable resources, the exploitation of which could lead to diversifying and completing the energy mix: airflows, hydraulic energy (kinetic and potential energy), temperature gradients, pressure gradients, etc. Technologies such as wind turbines or wave power systems already enable a number of these renewable energy reserves to be exploited, and are either at the commercial stage (wind power in particular), or at the demonstrator stage (some wave power, tidal power and hydro power systems, etc.). However, capturing these diffuse resources could gain new impetus thanks to exploration and development of breakthrough concepts, opening the way to innovative technologies which will become economically viable in the medium and long term.

### 3.2.2 **Research theme: Use of the subsurface for energy purposes**

The subsurface, which provides the majority of our current energy resources, nevertheless remains a space that is still little explored and which should play a significant role in the desired diversification of the energy mix and the development of clean, secure and efficient low carbon energy.

Research projects are necessary to develop its potential, both for the extraction of key resources for energy production (geothermal resources, native hydrogen, fossil fuel resources, etc.) and for CO<sub>2</sub> and energy storage (heat, hydrogen, compressed air, water, etc.), enabling regulation of supply and demand. Advances to be made in terms of improving optimised use of the subsurface will benefit all energy sectors (renewable, fossil fuel, nuclear).

As regards energy production, significant advances are in particular anticipated so that use of geothermal energy, a non-intermittent renewable energy, can be further developed, both for electricity and heat production.

Research projects are in particular sought on methodologies for evaluation of subsurface capacities (knowledge about the underground, substances to be extracted, storage capacities and conditions), the processes of access to the resources and exploitation in compliance with safety and environment protection regulations, monitoring and surveillance tools and strategies, interactions (impacts,

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<sup>5</sup> Issues relating to biomass resource availability and its mobilisation are addressed systemically in challenge 5 "Food security and demographic challenges".

synergies, conflicts) between the different uses of the subsurface, space and time planning (3D) for the different underground uses.

### 3.2.3 Research theme: Energy transformations and inter-conversions

Imbalances between types of end uses of energy and available resources necessitate - beyond recourse to storage devices - transformations, hybridisations and inter-conversions between different energy types, with efficiencies and losses as favourable as possible. We also need to look at demand and how it changes depending on uses and behaviours, themselves linked to political strategies (energy and environmental legislation) accompanying the energy transition.

Thus, in addition to direct burning of fossil fuel or "bio-sourced" energy resources (lignocellulosic biomass, organic waste, etc.) to produce heat, electricity or cogeneration of heat-electricity, two avenues are to be developed for more efficient production of liquid or gas fuels with low CO<sub>2</sub> emissions, and in particular biofuels, which are a priority area in energy transition scenarios:

- thermochemical conversion, the most mature technology, where the areas for improvement relate to specific pre-treatments to manage variability of incoming biomass, the treatment of inorganic compounds, ash and tar, the purification of "syngases" for direct use or conversion to liquid fuel, and the search for new catalysts to improve process efficiency;
- biological processes, employing microorganisms and/or enzymes, to break down the biomass and convert it to liquid or gaseous energy compounds, or to produce electricity directly.

Hydrogen conversion systems should also be considered, either based on technologies with low greenhouse gas emissions (low or high temperature electrolysis, thermochemical cycles) where improvements in efficiency and reliability are required, or, in a longer time frame, by direct production using cellular and molecular biological processes, or bio-inspired processes (fuel biocells, photolysis). In parallel, research is still necessary for a good understanding of the phenomena of degradation and ageing of fuel cells, to increase their life span and reduce costs: new catalysts reducing the need for platinum, proton-conducting polymer membranes, ion-conducting ceramic materials, reversible electrolyser/fuel cell systems, cogeneration fuel cell systems, etc. Lastly, while compressed form hydrogen storage is close to maturity, upstream work remains necessary on materials and structures suitable for solid-state storage, through adsorption or absorption.

Furthermore, with CO<sub>2</sub> capture from fossil fuel progressing, a CO<sub>2</sub> use method requiring further study is the production of synthetic hydrocarbons, thus enabling storage of intermittent renewable energies. Various methods are to be explored: thermochemical processes, hydrogenation, photoelectrocatalysis, photocatalysis, metabolisation by microorganisms, biocatalysis, etc.

Other non-energy ways of CO<sub>2</sub> use are addressed in societal challenge 3 "Industrial renewal". In more global terms, with a view to encouraging cross-fertilisation, the various components involved in the capture, storage and use of CO<sub>2</sub> (CCUS), conventionally addressed together, have been reorganised within issues necessitating similar scientific developments and bringing into play complementary disciplines.

### 3.2.4 Research theme: Managing space-time variabilities relative to energies

A significant proportion of renewable energies (wind, solar, marine energies) being intermittent in nature, grids for transporting energy and energy storage are necessary. Furthermore, the development of on-board storage systems should reduce dependency on fossil fuels (via transportation electrification for example).

Although certain storage types are already economically mature, in other cases there is much scope for improvement, or basic research is still needed for solutions to emerge:

- electrochemical storage for grid-connected applications but above all for on-board and portable applications, requires further improvements in terms of specific energy and specific power as well as reliability, safety and environmental balance sheet, while at the same time reducing costs. This requires work on electrodes, high voltage electrolytes, electrode/electrolyte interface issues, transition to the nanometric scale, alternative electrochemical couples or use of organic materials;
- storage in supercapacities requires a significant research drive in order to improve energy density (new organic electrolytes for a larger electrochemical window and improved security, increased carbon capacity, etc.). Hybrid or asymmetric systems are other avenues to be explored. Lastly, the high potential for innovation that exists in the area of supercapacities with aqueous electrolyte, raises the possibility of reduced costs, while at the same time improving security;
- magnetic energy storage, particularly in the case of superconductors (SMES);
- other types of high capacity stationary storage (compressed air, inertial, etc.);
- heat storage (refractory materials, thermochemistry, etc.) over time periods compatible with intended uses.

Sources of energy production, conversion and storage, managed at local scale (own use) or further distributed over the territory, lead to new management strategies for these sources in smart grids, at different spatial scales. Research projects are anticipated in particular on:

- the integration of homogeneous or heterogeneous elements in modules and systems of higher capacity and/or functionality (photovoltaic systems including grid connection or otherwise, combination of a number of storage solutions, etc.);
- security (resilience and reliability) and safety of systems and their integration into grids;
- managing inter-conversion and interoperability between energy grids (electricity, different gases, heat, etc.), as well as connections and interdependence with communication networks;
- managing grids, integrating space-time prediction of renewable energy production and energy demands; in this regard, issues relative to the development of micro-grids (in particular direct current electric grids), local consumption (including own use) and the design of flexible energy use modes (in particular in industrial processes), with load-shedding or erasure, should be considered;
- better knowledge of uses and behaviours with respect to socio-economic characteristics; this will be a case of studying the determinants of consumption, lifestyles and changing trends which interact with space-time variations of energies and influence how they are managed.

### 3.2.5 Research theme: Energy efficiency of processes and systems

Substantial energy savings can still be obtained by first working on energy production processes, in connection with either conventional energies or the new energy technologies. Research work is also anticipated on specific processes<sup>6</sup> in manufacturing industries via improvements to existing production processes, research into alternative processes which are more economical in terms of energy or CO<sub>2</sub> emissions, process intensification, etc.

Auxiliary systems should also be addressed (motors, turbines, pumps, heat and cold production systems, ventilation, etc.), as well as high efficiency electric actuator and generator systems reducing in particular usage of rare-earth elements and reliable and highly energy efficient power electronics and control (packaging, integration of storage, renewable energies, etc.).

Research into components and systems should take account of environmental constraints (functioning in extreme conditions, mechanical constraints, minimising dirt build-up, corrosion, etc.), but also usage (reliability, robustness, ease of use, quick return on investment). Work should also focus on digital modelling and simulation, multi-scale and multi-physics, for a better understanding of the phenomena and to identify, *ab initio*, the most relevant areas for improvement.

A major challenge in energy efficiency is work on methods and processes for the collection, transportation and recovery of waste heat, either by means of thermodynamic systems (heat exchangers, heat pumps, organic Rankine cycles, etc.) or by means of thermoelectric systems, which to be viable require improvements to the thermoelectric figure of merit and employing new architectures. More generally, it involves developing appropriate mechanisms for the recovery of waste energy.

In addition to seeking greater energy efficiency, the "decarbonisation" of energy should be based on increasing the proportion of electricity generated from "decarbonised" sources, in industrial processes (for example, induction or microwave heating) but also on developing and optimising combustion processes with lower greenhouse gas emissions, integrating in particular the capture (post-combustion, pre-combustion, oxy-combustion) and transport of CO<sub>2</sub>. Research projects should aim to improve the technico-economic, energy and environmental performances of these breakthrough processes.

### 3.2.6 Research theme: Socio-economic approaches to energy use and the impact of new energy technologies

Social sciences and humanities should provide important insights in a context of an energy transition which will affect all of society: analysis of social transformations connected with changes in technological paradigms (issues of equity, vulnerability, etc.), the study of interplay between players, of the determinants of consumption, practices and factors of change, the contribution of cognitive psychology, social psychology and economics to the study of non-financial incentives ("nudges") with the objective of controlling or reducing demand, understanding the phenomena of rejection or adoption of innovations, the construction of business models which render viable certain low carbon options, industrial strategies and organisation of production and distribution ecosystems, the functioning of energy markets, improvements to "energy-economy" models through consideration of the inaction and behaviours of players in different sectors. The science-society dialogue around perception of subsoil, its use and governance necessitates research at different levels including historical, sociological, economic, legal, etc. Proposals linking up with the challenge "Innovative, inclusive and adaptive societies" are particularly encouraged.

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<sup>6</sup> See also the challenge "Industrial renewal"

This also involves analysing current barriers to the development of renewable energies in France (centralisation, difficulty in re-conceptualising the energy mix in accordance with national and European objectives, etc.) as well as issues of safety and vulnerability associated with the emergence of new technologies. Similarly, social transformations linked to changing resources and needs should be taken account of (solar and wind technologies, which affect the local area more than conventional energy systems, own use, etc.). Lastly, optimisation of energy systems at single territory level (cf. challenge "Sustainable mobility and urban systems"), in the context of developing circular economy concepts is to be reconsidered.

### 3.2.7 European and international initiatives

Bilateral partnerships are possible in the context of this call for proposals. You should consult the annexes by country describing the conditions and thematic or disciplinary fields concerned by these bilateral partnerships. Furthermore, European actions could be specified in connection with this societal challenge in the form of specific calls for proposals. We recommend that you consult the calendar of international calls for proposals on the agency's website.

## 3.3 Industrial renewal

Industrial renewal will take place through profound changes. Industrial performance must be reconsidered in a societal perspective. This societal perspective introduces new players with whom we need to invent and build ways to interact. This industrial change is essentially based on the spread of **key enabling technologies (KET)**<sup>7</sup>. Apart from their high growth potential, they represent an opportunity at both the European and French level to bring basic research closer to industrial research and lead to the emergence of new industrial sectors. A significant proportion of research proposals selected to stimulate industrial renewal will therefore be based on key enabling technologies.

This societal challenge therefore covers a wide field corresponding to several disciplines and several industries (e.g., manufacturing industries, chemical industries, food industries, etc.). The objective is clearly to support the development and competitiveness of French industry. Future issues and constraints should be fully integrated (Carbon and water footprints, energy saving, reducing pollution, elimination of toxic substances, saving natural resources, etc.) to prepare the way for a clean and more "sustainable" industry, and one that is in fact more competitive. The human dimensions of industry and work should also be taken into consideration (new collaboration systems, new competencies, participative innovation, corporate responsibility, health and safety at work, etc.).

The challenge is constructed in particular based on recommendations by the Alistene, AllEnvi, ANCRE and Athéna alliances. It also benefits from the conclusions of the FUTURPROD ANR's Foresight workshop (ARP) on future production systems. The challenge is structured around 5 axes; these will also enable an integrated appraisal of the research projects from upstream (TRL 1) to future applications (TRL up to 4):

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<sup>7</sup> Key enabling technologies: [http://ec.europa.eu/enterprise/sectors/ict/key\\_technologies/](http://ec.europa.eu/enterprise/sectors/ict/key_technologies/): advanced materials, biotechnology, nanoelectronics, nanophotonics, nanotechnologies, advanced manufacturing.

- Work: organisation, relations, training, health, etc.
- Production sciences and technologies, the digital factory
- Products: design, processes and materials
- Sustainable chemistry, chemical engineering and white biotechnology
- The contribution of nanoscience and nanotechnology to functional materials and biotechnology

This societal challenge in part incorporates the 2011-2013 cycle programmes "Materials and Processes for High Performance Products", "Sustainable Chemistry – Industries - Innovation", "Nanotechnologies and Nanosystems" and SIMI 3, 7, 8, 9, 10 and SHS 1, 2 and 3 of the blue-sky "Blanc" programme.

### 3.3.1 **Research theme: Work: organisation, relations, training, health, etc.**

The industrial organisations of tomorrow (increasingly globalised, virtual, part of networks) will naturally give rise to new work organisations. They will necessitate the development of new qualifications and lifelong renewal of skill. Health and safety at work issues are the concern of all of society in multiple ways: legal, psychological, health related, societal, etc. These changes will have to be based on different professional relationships. Major international surveys have shown in particular that absence of social dialogue between the social partners in a country greatly jeopardises its companies' competitiveness. Therefore industrial renewal cannot happen in any significant way by adopting a purely technological approach. All aspects relating to work, its organisation, new forms of collaboration involved in it, should also be the subject of research. The following orientations should be noted, this list not being exclusive.

**Developing new professional competences.** In a production system founded on advanced technologies, human resources must be continually renewed so that competencies can adapt quickly to changes. In addition, the development of operator competencies depends on the conditions offered by his/her working environment (learning, collective work, feedback, etc.). It thus appears necessary to better identify resources to be mobilised in the work organisation and in order to develop competencies. It is important to anticipate organisational transformations imposed by flexible production and globalisation of logistics chains. Shared information systems will affect the manner in which collective work or work as part of a network is constructed. Infrastructures will be necessary to support data sharing and construction of a common language. These new forms of task division will encourage learning and innovation.

**Producing while ensuring health and safety at work.** Occupational health and safety regulations are increasingly necessary to prevent and manage risks potentially generated by production systems and technological innovations. The issue of asbestos, major industrial accidents and awareness of the impact of innovations on the environment lead us to review the place of civil society in innovation, notably in connection with matters of health and safety. Consideration of professional and industrial risks is therefore a response to legislation but also to a growing societal demand. Globalisation also increases risks of exposure to insecurity: threats of instability for certain populations constitute a brake on creativity and innovation.

**Inventing new collaborative mechanisms.** A production system that takes account of societal changes must also consider the instruments which circulate among players and are intended to encourage their collaboration for production and innovation. To develop collaborative mechanisms, industrial players should take better account of changes in working relations, new organisational possibilities for remote working and the need for professionalism in certain business areas. Another

element, mobility in the wide sense (product, person-skills, production, organisation) is to be considered as geographically more strongly which will also determine the route to globalisation.

**Developing Corporate Social Responsibility (CSR).** With the development of activity by companies, in particular industrial, their impacts on society and our world have become increasingly consequential. They affect not only the area of activity specific to these companies, the production of goods and services, but they also generate numerous knock-on effects (externalities) which are evident in many areas such as the functioning of the economy, health, the environment, solidarity, etc. Awareness by society and by companies in this respect is relatively recent and clashes with conventional governance of companies. The development of corporate social responsibility arises rather from the mutation of a technico-economic system underpinned by values and rights.

**Developing participative innovation.** Man's relations with the ecosystem will have to evolve to adapt to new products and environments both of usage and implementation of value creation processes. This takes place through better consideration of the desires, feelings and sensibility of human beings as producers or consumers. Companies must better integrate the individual human being into their participative innovation dynamic while at the same time protecting their intangible assets.

### 3.3.2 **Research theme: Production sciences and technologies, the digital factory**

This theme targets upstream or fundamental research on changes in industry, in particular manufacturing industry, but not excluding other industries. Means of production and the associated organisations should be considered taking a systemic overview. For all these new issues ICTs clearly play an essential role. While considering the needs of industries, more fundamental projects targeting stumbling blocks, models, methods of analysis and optimisation, new methodologies or tools, new concepts are perfectly eligible.

**New smart technologies.** The main issues relate to both technologies themselves and their design, implementation and interaction with users.

*Robotics: a vehicle for productivity and a thriving new sector.* The diffuse nature of robotics-related research and technologies means that it is of key importance to a number of industrial sectors involved in manufacture. The issues concerned are: mobile manipulation and dexterity, high speed and high precision operations; design and control of industrial robots, for production robotics and modelling and analysis of sensorimotor and cognitive functions; consideration of humans in interaction, for service robotics and cobotics. This area is seen as a priority for competitiveness of companies established on the national territory.

*Mechatronics and co-design of production and control.* The traditional approach of sequential development, separating mechanical design from control functions inserted into components, equipment parts and machines in the form of software, is no longer viable, given growing complexity and the need to make optimal use of resources. Thus, this challenge involves developing a modern "co-design" approach incorporating integrated mechanical, automatic and production design.

**New collaborative and interactive mechanisms.** The quality of collaboration between organisations and/or all stakeholders and machine/software/human interactions, at all stages (design of products and systems or during production) is a decisive factor in performance.

*Appropriate human/machine/software interactions* Developments should be based on agile approaches incorporating hardware and software but also usages and technologies with a user centred approach. They should provide increasingly open access to Big Data and increasing



interoperability between digital infrastructures and take account of issues of security and personal privacy.

**New digital technologies serving the products and factories of the future.** The digital factory, enabling early and integrated simulation of new products and their production systems, is becoming a reality. New issues are therefore emerging in terms of knowledge optimisation and re-use, in a distributed and collaborative context. Notions such as ambient intelligence and smart product enable us to envisage new modes of organising and managing production systems, but also to de-compartmentalise the stages in product life cycles, creating interaction between designer, manufacturer, distributor, user, collector and recycler in a framework of sustainable development.

**A logistic for new organisations.** Future industrial organisations will be circular and multi-scale. They should be formulated taking into consideration levels starting from closest to market up to the global scale, while ensuring maximum re-use of materials. For these organisations a new logistic will have to put in place. We will have to be able to design short loop circuits. We must also migrate from a corporate network logistic to a service network logistic ensuring interoperability of logistic organisations on a larger scale through standardisation of physical elements, protocols for communication between information systems and communicating objects.

**Training and new production tools.** Industrial renewal entails new tools and new methods in which workforces must be trained. It also requires the creation of new production models, from the digital factory to "FabLabs", or other cooperative structures in which new products can be designed, prototyped and tested at lower cost and in a shorter time period, not forgetting the emergence of "crowdfunding" platforms, having the capacity to quickly assess the potential existence (or absence) of a market.

### 3.3.3 **Research theme: Products (design, processes and materials)**

This covers the research that takes place at the beginning of the chain leading to the products: from materials through processes to design. More fundamental projects aiming, for example, at bottlenecks, new methodologies or tools, new materials (molecular materials, etc.) or processes and new concepts are also perfectly eligible. In general, approaches incorporating both experimental approaches and numerical simulations, as well as lifecycle analysis are preferable. More specifically, and especially for public-private partnership projects, priority is given to the following areas:

**Designing features and functionalities rather than products.** Industrial systems analysed in terms of the discrepancies between declared and real performance by the actual products. This holds true both for immediate performance and its evolution over time, and also for technical and economic performance as well as environmental and social performance. Focus will be on the comprehensive solution which meets the demand rather than the product itself which is just one of the elements. The concept will be applied to the entire lifecycle and for all types of performance. The "systemic-circular" view is ideal in functional approaches.

**Produce more eco-efficiently.** Tomorrow's production systems must be sustainable, i.e. integrate and maximise the benefits of economic, environmental and societal impacts. Producing eco-efficiently allows firms to distribute at competitive prices products (or services) that meet society's needs while reducing the ecological impacts and the use of resources throughout the lifecycles of these products, which will then be recycled or reused. The scientific aim is to increase innovation all along the supply chain in raw materials and energy: procedures that use less energy and consume fewer materials; systems for reusing materials and energy; mechanisms to encourage the general

public and finally eco-design methods which deal with problems as far in advance as possible and reduce them to a minimum.

**Raw materials, strategic materials and metals.** Pressure on raw materials stems from their scarcity or from environmental issues (CO<sub>2</sub> footprint, toxicity, eco-toxicity, and REACH). For aspects concerning scarcity and availability of strategic materials and metals, projects should aim at:

- looking for substitutions for the scarcity (intrinsic, economic or strategic) of strategic materials and metals;
- clean disruptive processes (extraction and recycling) that produce materials with higher added value or evolve towards a “product” status (metals, plastics, etc.) particularly from waste flow;
- optimising the use of raw materials (improving performance, improving sustainability).

Regarding the environment, it is important to:

- anticipate possible substitutions for substances which might be prohibited (REACH), notably for polymer-based materials;
- propose possible substitutions for materials and substances known to be toxic and already or possibly subject to authorisation (REACH).

**Materials and functionalities for competitive products.** This point aims to encourage research projects from materials to end products. To make state of the art products it has become standard procedure to forecast behaviour through simulation and modelling tools (including multi-scale). One challenge is to be able to design to maximum precision, i.e. the bare minimum (increasing competitiveness and saving materials) or to design dedicated materials (alloys, composites) and structures (“Materials by Design” approach). There is still a need for progress especially in forecasting lifecycles (damage, corrosion and related incidents). Research into materials destined for use in extreme conditions (temperature, heat flow, stress, irradiation, corrosion/oxidation, etc.) is still relevant, consolidating the competitive advantages in the aviation, automobile or nuclear power industries for example. In more complex situations, multi-physical approaches are essential. This point is closely linked to the “Information and communication society” challenge, in that developing High Performance Computing allows for exploration by simulation of fields in a wide range of parameters, thereby only actually needing to conduct the most necessary experimentation.

**Optimised and innovative processes.** In many cases, the materials used have reached a certain maturity and the way forward now involves processes (shaping, assembling, surface treatment, etc.). The specific links between materials, processes and products take on particular importance. Great care must be taken in assembling multiple materials and in the additive manufacturing process. It is also worthwhile taking a closer look at ways of processing ores and waste products (bioprocesses, hydrometallurgy, physical treatment, etc.). Research into processes for separating complex products and disassembly techniques could be extremely important for large-scale recycling.

### 3.3.4 **Research theme: Sustainable chemistry, chemical engineering and biotechnology**

Generally, this theme aims at promoting research aiming at the green chemistry concepts, but more fundamental chemistry projects are also eligible. More specifically, for public-private partnership projects, priority should be given to the following fields:

**Optimisation of carbon resources.** Here we mean the synthesis of new or existing chemical intermediates from raw material from agriculture, forestry, the sea, CO<sub>2</sub> recovery (also addressed in societal challenge 2 for the production of fuel) or waste recovery. Particular care must therefore be

given to selective disassembly processes, and to the functionalities expected from bio-sourced products. It also concerns carbonaceous chemistry, particularly the activation of methane, and recycling polymers: how and how far to break down the polymer to obtain new precursors.

**Efficient reactions and processes** – Designing innovative processes must take into account the quality of the raw material and always aim to reduce consumption of materials, energy and especially water. Innovation in processes is based on fine-tuning equipment to remove bottlenecks in intensification processes and solicit recent work on new extraction, purification and separation technology, the development of reactors implementing activation techniques, new catalysers, and in-situ regeneration methods of these catalysers, the development of related methods for online analysis, etc. Multi-scale and multi-physical modelling, simulation and optimisation of these new systems are also essential and must be based on simulations. Process safety must be taken into account, particularly in creating tools to conduct the processes safely (parametric sensitivity analysis of models assessing the consequences of accidents). Finally, research can be based on eco-design of processes and more specifically the methodology for analysing lifecycles (re-examining chemical databases, similarity of models along the value chain, optimisation and simplification), and the methodologies to measure the environmental footprint.

**“White” biotechnology**, through the development of new processes. Here we look at the use of biotechnologies to manufacture, process, or break down compounds thanks to enzymatic or fermentation procedures for industrial purposes, used as an alternative to classical chemical procedures. “White” biotechnologies are gradually being applied in industry, but there is still plenty of potential for technological innovation. White biotechnologies do not only concern plant chemistry, as they can also apply more widely to organic chemistry.

This topic is also addressed in the challenge “Clean, secure and efficient energy”, for aspects covering fuels and the challenge “Food security and demographic challenges” for bio-transformations and biological resources. Projects integrating issues covered in several societal challenges will be welcome.

**Methodologies for new compounds, new products.** This means designing new products to replace substances requiring REACH authorisation and/or having original properties that correspond to society’s demands and/or allow for reuse of the material. We expect progress in looking for substitutes for substances submitted to REACH for authorisation (CMR1, CMR2 criteria) or other substitute products leading to products that are more eco-friendly, or recycling: reuse and second life. Developing *a priori* evaluation methods for the reactivity (*in silico approach*) of these new products plays an essential role in the safety of facilities and biological and environmental impacts. Properties could be screened (QSPR, QSA approaches) to develop predictive methods based on molecular descriptors of the structure-property relationships and the chemical reactivity of the products. Drawing up databases is also included in this topic, which draws on the skills of chemoinformatics specialists. It is also important find new solvents, milieus and multipurpose objects using formulation and more specifically green formulation.

### 3.3.5 Contribution of nanoscience and nanotechnology to functional materials and biotechnology

Nanotechnology comprises key generic technologies recognised by Europe, which are halfway between the raw materials and the applications, in that they manufacture the generic components needed in numerous other industries. The ability to produce high-tech, functional materials requires the production of the basic building blocks and the ability for everyone to handle them. **The use of nanotechnology in the fields of nanoelectronics and nanophotonics comes under the “Information**

**and communication society” challenge.** Research in this challenge therefore concerns the use of nanotechnology in **nanotechnology** to produce and classify the building blocks (nanoparticles, nanotubes, nanowires and graphene), for use in a number of high-profile fields such as **functional coatings** (optical, magnetic, electric, etc.) or prior to the nanoelectronics electronic components, the **functional materials obtained by multi-scale assembly of nanoparticles**, for use as catalysers or to include them in energy recovery and storage systems.

In biotechnology and in preparation for medical applications (see the nanomedicine themes in the “Health and well-being” challenge), we will back research on the design of nanovectors, bio-inspired processes and assemblies, and nanoparticles for imaging.

Providing **microfluidic tools for innovative production processes** in all of these materials may also be considered. Finally, in order to ascertain the specific effects of nano dimensions, research on instruments enabling nanoscale metrology, either in an ideal situation or in complex matrices will also be supported.

### 3.3.6 International initiatives

Bilateral partnerships are envisaged as part of this societal challenge. The appendices should be consulted for each country, describing the terms and thematic or disciplinary fields concerned by these bilateral partnerships. In addition, international initiatives are foreseen in relation to this challenge in the form of specific calls. We recommend that you consult the calendar of international calls for proposals on the agency's website.

## 3.4 Health and well-being

### 3.4.1 Context of ANR work in the “Health and well-being” challenge

The “Health and well-being” societal challenge covers a wide area of research to meet the natural aspiration towards well-being in the context of optimal policies for Health Care. This implies sustained fundamental research at the frontiers of knowledge in conjunction with clinical and health care advances. 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 observing living organisms functions as well as from the combination of multidisciplinary approaches are benefiting the human health.

The approaches and concepts of biology now rely on engineering, physics, chemistry, biomaterials, mathematics, information technology, social and economic sciences, humanities, and in return contribute to these disciplines by stimulating bio-inspired technologies.

Understanding the mechanisms of the living and the factors influencing the well-being of mankind in his environment is a goal that goes beyond the realm of Health Care. The field of biomedical research is particularly wide and must consider such context marked by the growing ageing population or the changes in living environment and social behaviour that can promote the development of pathologies. The pathologies such as, damage to the nervous system, metabolic or nutritional disorders or infectious diseases, would certainly require nationwide healthcare measures.

“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 for the industries of biotechnology, pharmaceuticals, diagnosis and medical devices, etc.

The “Health and well-being” challenge shares many items with the following challenges: “Information and communication society”, “Innovative, inclusive and adaptive societies” and “Food security and demographic challenges”.

The main fields of research concerned by this challenge were defined on the basis of the strategic agenda for research and innovation “France Europe 2020” backed by contributions and recommendations from the CNRS, the Aviesan, AllEnvie, Allistene and Athéna alliances for the ANR 2014 programming, and by the road map put forward by IFRES.

The ANR’s work aims to complement activities carried out by other stakeholders. We therefore do not support research in fields of Cancer research, HIV/Aids and viral hepatitis, which are supported by the INCA and the ANRS, except for projects in public-private partnership on these topics which are eligible for ANR funding. We also exclude some public health issues which are funded by the IRESP (public health research institute). For clinical research, the ANR will not consider projects that are eligible in the Clinical Research Hospital Programme (PHRC), nor research on health and healthcare systems that are eligible in the Research on Healthcare Performance Programme (PREPS) managed by the DGOS.

The “Health and well-being” programming will allow researchers to propose projects that are part of long-term research programmes in the ERC Life Science fields LS1 to LS7. Expert skills from other disciplines are welcome: Chemistry, Physics, Biomechanics, Mathematics, ICT and digital science, social sciences and humanities, as well as the use of varied animal, plant or microbial model systems. The collaborative projects can be single- or multi-disciplinary and will be reviewed for their scientific excellence and their relevance to the challenge, particularly in the programme framework as proposed by the Aviesan alliance.

To encourage emerging cross-disciplinary fields and meet issues in the “Health and well-being” challenge, 18 sub-themes, mostly cross- and multi-disciplinary, will be given particular support in 2014. These sub-themes vary greatly in their scope, their ambitions and their outlines. They do not intend to cover the whole field of biomedicine, which therefore remains open to projects that do not come under any of these sub-themes. For certain sub-themes, specific instruments will be considered (see section 2.1).

This societal challenge partially corresponds to the former ANR blue-sky “Blanc” programmes SVSE1 to SVSE6 and SVSE8, SIMI7 and SIMI9, as well as the cross-disciplinary programmes CESA and DSS, and to the “biology health” thematic programmes, including MALZ, SAMENTA, PRTS, RPIB, TecSan, included in the ANR 2011-2013 programming.

### 3.4.2 **Research theme: A new representation of the living world**

The theme “A new representation of the living world” aims to decipher the multi-scale mechanisms of physiology, development and ageing implemented in the living world, an essential stage in understanding and diagnosing disorders. The research supported in this theme will address approaches and questions related to genetics, cell biology, developmental biology, evolutionary biology, structural biology and physiology. It will use multi-level and multi-disciplinary methodologies of imaging, integrated physiology and experimental medicine. Research aiming to bring out new animal, plant and bacterial study models will also be supported with the expectation of short- or

long-term outcome in human and/or animal health. Research projects in this theme must go beyond the descriptive stage of observation and sequencing of genomes and address the comprehension of the intimate functional mechanisms that will contribute largely to health issues.

#### Sub-theme 1. Deciphering the elementary biological functions and their integration

Cells are the elementary forms of life. This initiative aims to understand how animal and plant cells are made up from assembled molecules, how they grow, multiply, differentiate and move in response to stimuli from the environment, how they work together to form a multi-cellular organism, and how these mechanisms found their place during evolution.

#### Sub-theme 2. Exploration of lesser-known branches of the living world through multi-scale and multi-modal approaches

This initiative covers the phenotype and functional description of the lesser-known branches of the living world and of bacterial populations, in different environments as well as in symbiosis with superior organisms and man. The emergence of new study models will be supported, particularly short life-cycle laboratory models on which functional studies can be done genetically or pharmacologically.

#### Sub-theme 3. Genetics: genotype-phenotype relationship, genome-environment interactions, epigenetics: chromatin and non-coding RNA

Distinguishing the genetic and epigenetic bases of human diseases is an important issue. Studying the variations of genomic regions targeted by epigenetic modifications and non-coding RNA is an extremely interesting area of research, which includes cutting-edge fundamental research and the validation of the findings arising from it, by studies conducted on human populations and model species. This targeted initiative requires close cooperation between biologists, clinicians, physicists, mathematicians and computer scientists.

#### Sub-theme 4. Study of biological systems, their dynamics, interactions and inter-conversions at molecular level

This sub-theme aims to understand the dynamics of coordinated systems at the subcellular or cellular level, by taking into account two levels of integration: the use and development of different technologies, allowing for multi-resolution synergies in space and time; multi-scale integration of heterogeneous, structural and functional data, so as to integrate the atomic and cellular and even tissue aspects. The aim is to: 1) understand, visualise and quantify the mechanisms that allow molecular components to work together in their cellular environment; 2) promote new technologies allowing experimental approaches on single molecules and cells through multi-disciplinary approaches.

#### Sub-theme 5. Exploration of the nervous system in its normal and pathological functions

The aim of this sub-theme is to understand the fundamentals behind the hierarchical assembly of thousands of molecular, cellular and tissue components in the nervous system and the sensory organs, how their dynamics and plasticity generate the functional properties and how the alteration or malfunction of one or more of its components can cause disorders. Hence, this sub-theme encompasses neural foundations of cognitive functions and behaviours (neural code, multi-modal sensory integration, memory, recognition of objects and actions) and development of individuality in the social dimension (self-awareness, body awareness and control, thought, language, symbols, individual or social relationships, etc.).

#### Sub-theme 6. Study of the defence mechanisms of organisms

To cope with the increasing frequency of inflammatory, allergic and auto-immune disorders, the aim is to identify the susceptibility genes, to decode the interactions between genes and environment, describe the dynamics of intercellular interactions in the various tissues and organs, and identify key molecules and processes necessary for the organism to function adequately in normal and stress situations. This sub-theme will also include functional screening of cells allowing integrated analysis of the immune system, to work out efficient strategies for immuno-monitoring to better describe and predict the state of the immune system at different life periods.

#### 3.4.3 **Research theme 2: Improve health through personalised medicine, diagnosis, prevention and therapy, palliative strategies, considering living organisms in their environment**

Biomedical research initiatives are also anticipated in fields codified by the ERC items and sub-items LS4 to LS7 (approximate equivalents to former SVSE 1, SVSE 3 to 5, SVSE 8), aiming at better knowledge of pathological processes leading to risk subtraction approaches or establishing compensation strategies, from the level of the individual organism to the level of the community. This theme will cover the following fields:

- Research leading to the identification of new biological or imaging biomarkers, of the risk factors involved in developing diseases, and of new treatment targets
- Research towards prevention strategies, subtracting risk factors or strengthening the resistance mechanisms of individual subject or populations
- Management and use of e-Health

#### Sub-theme 7. Organisms and virtual disorders

This initiative, focused on the current major issues of digital and personalised medicine, consists in creating realistic virtual biology and medicine (*in silico* simulation of the anatomy, function and metabolism) and comparing virtual models to data acquired by physical systems (existing or to be invented) in biology and/or medicine (patients), combining health technologies and an understanding of living systems. This targeted initiative, to be taken together with the societal challenge “Information and communication society” will require consortia of teams specialised in information and digital technology.

#### Sub-theme 8. Information and digital systems in healthcare, phenotyping

This initiative covers tools for preclinical and clinical phenotyping integrating high throughput biological data and new biomarkers facilitating the nosological breakdown of common illnesses. This includes big data generation of management, intensive harvesting and integration of data often from different sources (biological, genetic, clinical, imaging, environment), massive data processing, data interpretation, digital simulation, usage for aid in decision-making, data exchange, security and ethics in managing this data.

#### Sub-theme 9. Microbiomes and microbiome-host relations

The aim is to identify the different bacterial species of normal and pathological flora and understand the relationships between bacterial flora and host, and to assess the effect of microbiomes on higher organisms function, their influence on the genotype-phenotype relationship, for example in relation to obesity or metabolic syndrome, to sensitivity to infections, to inflammatory, auto-immune or neuropsychiatric disorders.

#### Sub-theme 10. Emergence and transmission of pathogens, resistance

The aim is to support multidisciplinary research that takes into account the social and environmental aspects of infectious diseases in order to prepare for a possible pandemic. Projects will cover inter-species transfers, the seasonal aspect and periodicity of transmission; behaviour of vertebrate hosts, carriers and pathogens; and the possible interventions (vaccination, treatment, etc.). This theme concerns research on societal and public health aspects, on biodiversity, animal carriers and their dissemination in the environment, all of which comes under the 'One Health' initiative.

#### Sub-theme 11. Environmental health, predictive toxicology

This initiative aims to support projects on the mechanisms and health effects of endocrine disruptors. Research on endocrine disruptors should respond to a highly significant scientific and societal issue for the following reasons: 1) the proven or suspected effects of these products affect vital functions, 2) they are standard products, therefore the general population is in contact with many of them, 3) they can act in combination, 4) they apparently represent a new toxicity mechanism which could be extrapolated to other processes (neuronal, immunological, etc.), 5) there is a need for international regulations to which France must propose an enlightened contribution, as 6) significant industry sectors are concerned, especially in the search for substitutes. These disruptors have an original mechanism of action which interferes with physiological mechanisms, stressed out by their unusual dose-response profiles. Expected approaches in toxicology and ecotoxicology should cover pathways or networks of toxicity, systems biology, epigenetics, and target the vulnerable stages in an individual's lifecycle (foetus, puberty), the trans-generational effects, multiple exposures, or key epidemiology to understand subject populations in the environment. In epidemiology, preferred approaches are longitudinal studies that include the foetal period and population studies that explore the trans-generational effects and epigenetic mechanisms. They could be based on environmental cohorts, which should be supported.

#### Sub theme 12. Normal and pathological ageing, autonomy and quality of life

This initiative aims to support projects concerning ageing and senescence as examined from its biological as well as social aspects. Eligible projects include the biological mechanisms of ageing (causal pathways involved in cellular senescence) and age-related health concerns (immunological, metabolic, cognitive and neurological), as well as research projects addressing elderly integration, their ability to contribute to economic and social life (lifelong learning, etc.) and conditions to increase their autonomy (social innovations such as co-housing, etc.). Projects covering the development of new concepts around healthcare or ambient assisted living (home automation) and projects concerning the economic impact of ageing and its ethical and anthropological aspects will also be supported.

#### Sub theme 13. Psychiatry and mental health

This initiative aims to support projects addressing all causal factors (e.g. biological and social) of mental health, particularly those relating to the pervasive developmental disorders and addictive behaviours. In both fields, particular attention will be given to projects developing an inclusive approach (determinism, be it genetic from other origin, cerebral imaging, neurosciences, behavioural data on the alteration of cognitive and communicational functions) and to those that lead to translational research and the design of evidence-based care protocols.

On the subject of PDDs and the autism spectrum disorders, support will be given to projects covering alteration of brain plasticity and its early markers, and the impact of environmental factors, and also to projects dealing with disorders affecting meta-representational and social cognition abilities, executive functions and attention. Particular attention will be given to studies concerning speech



perception disorders and grammar/lexical mastery and fluency relatively to schooling and social inclusion of autistic populations. The initiative will also support research on remediation methods, stemming particularly from the information sciences, to improve the language skills of the people affected.

For research on drugs and addictive behaviours (to be taken in a wide sense, without distinction between licit and illicit and including non-substance-related addictions), support will be given to projects aiming at a biological explanation of the addiction phenomena (identifying underlying cellular mechanisms, genetic susceptibility, characterizing biomarkers enabling an analysis of vulnerability factors) and those proposing a study of addictive practices seen as social behaviours (self-perception of the users, analysis of motivations which might be socially differentiated, thereby generating knowledge around social inequality in health). Particular attention will be given to projects with an interventional and evaluative dimension to assess the impact of treatment protocols and public policies (supervised injection sites, etc.). Concerning the drugs as such, we will also support projects addressing how the drug market is promoted and operated, and on the supply circuits.

#### 3.4.4 **Research theme 3: Public Health**

Projects concerning public health must cover one of the three priority areas defined by the World Health Organisation: understanding the causal chains that lead to gender, environmental or cultural socio-economic inequalities and transform them into risk factors; and gaining greater insight into how a health shock or the onset of a chronic disease can aggravate social and economic inequality.

##### **Sub-theme 14. Social inequality in health care in France: health and prevention, primary care and social services**

The objective is to enhance cross-disciplinary research and provide hypothesis on possible ways of tackling social healthcare inequalities in France. An adequate response from public authorities to healthcare inequalities require prior studies on the social dimensions (lack of prevention, discrepancies in primary health care, interactions between health services and the social sector), and the behavioural, psychosocial, economic and biological dimensions, trying to elucidate the mechanisms explaining the impact of certain social determinants on health, and characterizing the amplitude and the nature of those who escape this causal analysis. The integrated analysis of socio-economic, psychosocial and biological determinants requires methodological developments. This initiative is cross-cutting with the field of Social Sciences and Humanities, and the societal challenge “Innovative, inclusive and adaptive societies”.

#### 3.4.5 **Research theme 4: Innovation in biomedicine**

This research theme concerns the translational aspects of research, towards clinical and/or industrial applications:

- Research that will validate new biological or imaging biomarkers and bring them up to the development stage or clinical usage;
- Validation of new treatment targets, research on new treatment compounds, innovative screening processes, research on new indications for already registered drugs, innovations in galenics and pharmacology;
- Research on regenerative and substitution biotherapies, biomaterials;

- Development of treatment strategies by physical and/or surgical means, with the help of robotic or digital technologies;
- Clinical validation of prevention strategies;
- Technological research in e-Health and telemedicine, therefore based on information and communication technologies applied to health care.

#### Sub-theme 15. Stem cell biology, tissue remodelling, regenerative medicine

This initiative covers the study of adult, foetal or embryonic stem cells in all appropriate species and models. It concerns studies of auto-renewal and differentiation of stem cells, reprogramming somatic cells as stem cells, and remodelling normal or diseased tissue. This sub-theme also includes the biotherapies targeting the stem cells and/or the tissue regeneration, as well as building an experimental modelling of the stem cell niches. The programme will include projects from very basic research right up to research aiming at medical or industrial applications.

#### Sub theme 16. Translational research in Health care

The incentive for translational research is intended to finance downstream projects supported by the ANR and upstream projects supported by the Clinical Research Hospital Programme (PHRC) of the DGOS. The aim is to support collaborative projects between laboratories and hospitals concerning scientific questions at the interface between fundamental research and clinical research. The outcomes from these projects must allow new hypotheses likely to be tested in a clinical research study.

The other goals are: i) to speed up transfer from the research laboratories to the healthcare institutions (“bench to bed”); ii) to speed up transfer from the healthcare institutions to the research laboratories (“bed to bench”); iii) to increase research aimed at clinically validating a concept and/or an investigation strategy or treatment designed from the findings of the exploratory research; iv) to take into account the constraints imposed by studies on human from the earliest stages of the research to reduce the risks of failure in later stages.

#### Sub-theme 17. Innovation in medicine, nanotechnology, innovative treatments and vaccines

This targeted initiative will support finalised biological and biomedical research projects, and will facilitate the transfer of knowledge between the industrial and academic partners in health care to increase French competitiveness in the biomedical sector. The area will concern only innovations intended for healthcare focusing on detection, diagnosis, prognosis, prevention and treatment, and on industrialisation and production. Projects on synthetic biology aiming to understand the biological mechanisms and tools that can be applied to health care come under this initiative. An important issue is to match the possibilities these technologies provide with actual medical needs. This initiative will give particular support to public-private partnerships projects.

#### Sub-theme 18. Technology for Health care

Engineering and digital sciences are powerful tools for transforming quality of life in the healthcare and autonomy sectors, and a determining factor for progress in medicine: research instrumentation, imaging and sensors, massive biological and medical data processing, help in diagnosing and in medical procedures, help in cognitive or behavioural therapies, intelligent prosthetics and orthotics. They provide an in-depth evolution in the healthcare system and improve quality of life, through e-Health, compensating for a disability and loss of autonomy.

The incentive on Technologies for Health care concerns applied research work with a significant potential for industrial development. It will support the dual participation of partners from academia and industry in conjunction with a transfer strategy.

### 3.4.6 Consolidating the national strategy by joint calls for proposals in initiatives such as 'ERA-NETs' or 'Joint programming initiatives'

In addition to the national and international initiatives from the bilateral agreements described in chapter 5, the ANR in its 2014 framework programme will strongly support groups wishing to work with international partners of excellence in joint initiatives such as the ERA-NETs and Joint Programming Initiatives (JPIs) calls for proposals. We recommend that you consult the calendar of international calls for proposals on the agency's website.

## 3.5 Food security and demographic challenges

In the next few decades, the ecosystems used to produce food or non-food resources will be in ever greater demand, not only to feed a growing world population whose needs are increasing fast but also to respond to the scarcity of raw material sources, especially by producing biomaterials. This will allow for better management and use of the many services of the ecosystems for a more sustainable development that takes into account economic competitiveness, employment and reduction of social inequality. We look for sustainable production of goods and services, using renewable, resilient and balanced methods. This implies the inclusion of governance and management of the activities and uses, which should be applicable in any given ecosystem.

This societal challenge aims to define the technological evolutions and economic, institutional and social support measures that will allow for a sustainable use of ecosystems (at environmental, economic and social level), while ensuring that the ecosystems exploited produce the necessary goods and services for optimal production while minimising the inputs and taking into account the other ecosystem services (biodiversity, bio-resource applications in industry or for energy, etc.) to be able to design more sustainable products, processes and distribution and marketing systems with high added value.

Bio-based economy, all the economic activities related to developing industries, processes and products of biological origin, is a sector which France, just like the rest of Europe, wishes to help increase. This ambition requires increased work in research and innovation in bio-resources, biosciences, biotechnologies and their combination with chemistry and process engineering, to complement the "Industrial renewal" challenge. Changing an economy currently mainly based on fossil carbon over to bio-based economy also requires major changes in lifestyles, economic models and the use of natural resources. A comprehensive and systemic approach is necessary.

Research work in the field of social sciences and humanities is an advantage in our ability to meet the demographic challenge of food security (minimisation of waste, understanding of the determinants of food transition, consumer patterns, etc.).

Collaborative projects in public-private partnerships are strongly encouraged, particularly for the research themes in agro-food and biotransformation of biological resources but also for the sustainable productions research theme. This challenge is divided into four scientific research themes: Sustainable productions, Agro-food, Contaminants, Biotechnologies: Biotransformation of biological resources, Health, and in a crosscutting theme for the integration of these various fields.

The influence of climate change on the resources of the various ecosystems and adapting these resources to global changes are addressed in challenge 3.1.

This societal challenge groups part of the programmes in the 2011-2013 cycle 'Agrobiosphere', 'BIOADAPT' 'ALID' and CESA, and the SVSE5, SVSE6, SVSE7, SHS1, SIMI9, SIMI7 in the blue-sky "Blanc" programme.

### 3.5.1 Research theme: Sustainable productions

All methods of exploiting resources (agriculture, forestry, aquaculture and fishing) are concerned in all the continental and marine ecosystems, involving the stakeholders who manage these resources. As part of the 'greening' of the new Common Agricultural Policy and the new Common Fisheries Policy, adapting productions must be part of an economically and ecologically intensive strategy. It includes the healthcare, environmental, economic and social issues specifically taking into account the reduction of inputs, the optimisation of water resources and soil reconstruction. The approach is necessarily systemic and has to take into account the impact on the economic sectors and on the territories. The notion of yield must be re-examined and based on living organisms adapted to the abiotic conditions in which they are produced (drought, rainfall, temperature, variability, organic soil characteristics, ecosystem constraints, etc.), but also to the biotic conditions to which they are subject, especially pressure from all the pests and pathogens. We particularly encourage research aiming to:

- **Foster biodiversity in farmed or cultivated environment** and develop the landscape ecology to implement green and blue corridors. Suggest ways of adaptation of the environment to foster biodiversity, and improve the performance and the functions of these ecosystems and their resilience in order to contribute to the good condition of habitat preservation.

- **Produce differently**: reduce inputs and optimise their effect. Pesticides must be drastically reduced (Ecophyto programme), optimisation of fertilisers (nitrogen, phosphorous), decrease of use of chemical compounds for protecting plants and animals, cutting energy costs and the use of water for irrigation while maintaining high levels of production. Micro-organisms, plants and animals physiology, biology, genetics and genomics all help to identify the genes involved and their regulation and the mechanisms involved in. This work will help to breed or select organisms adapted to the dual challenge of reducing inputs and maintaining productivity and competitiveness. To ensure sustainability and resilience of these adaptation abilities, it is also essential to define how they are expressed, transmitted and maintained from one generation to the next at the different scales of the organisms. Validating these mechanisms in their real conditions of use is an important part of this topic. Fostering research on alternative practices aiming to maximise the ecosystem services while limiting inputs (water, fertiliser, pesticides, etc.).

### 3.5.2 Research theme: Agro-food issues

The issues concern the quantity, quality, food safety and systems with their impacts on the health and well-being of consumers. To be more competitive, the agro-food industry needs to innovate through research to combine productivity, quality and safety while aiming to consolidate the sustainable management of the environment. So the agro-food industries need to anticipate and find solutions to the issues they face, and also they need to invest in innovation the better to meet the needs of consumers who want to buy safe and healthy products, pleasant and easy to eat, with

useful nutritional value, available to all and eco-friendly too. As an addition to the “Industrial renewal” challenge, research is particularly encouraged on:

- **Innovative technology, competitiveness:** one section consists in being able to integrate variety and variability of raw materials, optimise the formulations, processes and packaging, the consumption of fluids (energy, water), ensuring healthy plant and animal productions, retailing methods and use of food products.

- **Sustainability of the agro-food sector:** sparing use of energy, lifecycle assessment from producer to end user, assess the risk-benefit ratio of production chains or crosscutting multi-chain systems (retailing, logistics, catering, etc.), taking into account the constraints and requirements of the various stakeholders.

- **Healthy food:** work will concern improving the food for populations at risk, such as those who have no job security, those who are subject to nutrition-related illnesses (malnutrition, obesity, allergies, intolerance, etc.) and the elderly.

- **Safe food:** the interactions – synergy, antagonism or inhibition – between foods on the effects of chemical or biological contaminants ingested simultaneously and exposure and sensitivity of some populations to the adverse effects of contaminants in foodstuffs and the related risk analyses (linked with the research theme on contaminants). This study of food safety will extend to the whole industry (preparation, conservation, packaging, use by the consumer).

- **Optimised raw materials:** explore the diversity of cultivated or wild raw materials and the diversity of their molecular components to be able to renew and diversify the range at different levels of the chain. Producing new materials of animal, plant or microbiological origin will require an exploration of organism capacity in order to produce new molecules, or to find appropriate nutritional balance. Using improved varieties or species not recognised for these characteristics will allow for renewing or diversifying the range of food.

- **Loss and waste:** analyse the whole chain to identify the causes of loss, offer solutions to reduce waste (estimated at 30%) and develop recuperation and transformation processes to recycle these materials that have already been processed.

### 3.5.3 **Research theme: Biotechnologies: biotransformation of biological resources**

Developing a new industry in this sector requires finding innovative processes to make industries more competitive (agro-food and bio-based chemistry). Innovation necessarily requires a better understanding of chemical and biochemical mechanisms on the matrices, of biological mechanisms for microflora and microalgae and of developing the application of enzymes. Production biotechnologies (bioreactors, biorefineries, etc.) will have to be optimised and automated by promoting ecodesign and particularly by optimising the elements, water, energy, materials and packaging, etc.

Proposals will be coordinated with the “Industrial renewal” challenge, in particular research theme 4: Sustainable chemistry, chemical engineering and biotechnology and the “Clean, secure and efficient energy” challenge for bio-products in energy applications.

Research is particularly encouraged on:

- **Designing renewable foods and raw materials** for chemistry, materials and energy: this must integrate questions of sustainability, energy efficiency and the use of by-products and waste

materials as recoverable resources, including management of co-products. Creating food that is better adapted to economic and technological constraints and to consumer demand requires characterisation and development of the molecular and physical and chemical diversity of local living organisms or with original intrinsic properties or properties that have been “introgressed” into varietal improvement programmes.

- **Circular economy:** we must examine whether these new industries are able to integrate new constraints and generate new improvements in productivity in a world market. Among the issues that should be analysed are competition and complementarity between the production, processing and distribution industries.

- **Biological and biochemical synthesis:** the green and/or blue eco-friendly pathways will be supported and structured to solve the problems caused by their industrial production and will eventually lead to real ecological and bio-economic transition. Chemical synthesis is dealt with in the “Industrial renewal” challenge, particularly research theme 4: Sustainable chemistry, chemical engineering and biotechnology.

### 3.5.4 Research theme: Health issues

The impact of contaminants on ecosystems and on human health must be studied. This work will continue to study the significant interrelations between ecology (ecotoxicology) and human health (toxicology), with a section covering epidemiology, and social sciences and humanities (consumer behaviour). The impacts of emerging pollutants and industrial pollution on aquatic, air and soil environments will be sought. Solutions to reduce contaminants are an integral part of this initiative. Proposals concerning human health will be submitted in conjunction with the “Health and well-being” challenge, in particular under sub-theme 11 on environment contaminants and health, predictive toxicology.

The “One Health” concept will bring together research work on the pathogens of animal and plant productions and human health issues. An operational link must be established between predictive epidemiology, population dynamics, host-pathogen relationships, biological and eco-friendly control, spontaneous or induced genetic resistance and if necessary the use of new bioactive compounds. Cooperation is also desirable between the fields of toxicology and ecotoxicology, as some pollutants can alter the sensitivity of organisms to pathogens and cause a significant number of deaths qualified as “multifactorial” (bees or oysters, for example). The frontiers of this research theme stop at species and the impacts on natural and productive ecosystems. Proposals that cut across this theme and those of the “Health and well-being” challenge are eligible, but must mention the fact that they belong to two categories. Research on the following topics is particularly to be encouraged:

- Low-dose contaminations and long-term cocktail effects will have to be added to epidemiological studies to determine the risks for the most sensitive populations.

- Veterinary products. In animal breeding, we need to develop alternative solutions to drugs, residues of which can be found in food products or be discharged into the environment. The Eco-antibio 2017 programme intends to reduce veterinary use of antibiotics to limit the development or resistant strains.

- Selection of multi-resistant varieties and search for a fit to the abiotic parameters, pathogens and bio-aggressors. It will be essential to understand the generic or specific genetic, physiological, epigenetic and molecular mechanisms to develop tools and methods to select and improve the species with these multiple stresses. Genetic and physiological optimisation and diversification of these organisms will ensure their ecological resilience.

### 3.5.5 Research theme: Cross-cutting approach to the field

Cross-disciplinary research that develops systemic approaches could meet the needs of the bio-economy, the preservation of biodiversity and sustainable development. The various uses must be integrated into the same ecosystem to ensure sustainable development in the management of systems and resources. The question of land-use change is raised, as is the intensification or extension of food or non-food biomass production. Projects on land management and modes of governance in areas with severe constraints (coastal areas, catchment basins, etc.) are desirable. Therefore work on the transformation of natural, non-food resources (green chemistry), recovering brownfield sites (eco-friendly chemistry) and transformation of waste products into new materials and resources (sustainable chemistry) must be included in this study. Projects concerning the Mediterranean area, which suffers from considerable resource problems, will be particularly welcome.

### 3.5.6 International initiatives

Several international initiatives are likely to be introduced in connection with this societal challenge. They will be covered by specific calls. We recommend that you consult the calendar of international calls for proposals on the agency's website. The themes covered in European (JPIs, ERA-NETs) or international (Belmont forum) initiatives will not take priority at national level. Similarly, the topics covered by European calls in Horizon 2020 in 2014 will not be eligible for ANR 2014 funding.

Bilateral partnerships may be possible in this call. The appendices should be consulted for each country, describing the terms and thematic or disciplinary fields concerned by these bilateral partnerships.

## 3.6 Mobility and sustainable urban systems

This societal challenge aims to explore the ability of urban systems, built environment and transports to be transformed and integrate sustainable development principles. This requires drafting new charts to understand the processes which take into account the physical dimensions (flow of materials, energy, people, networks, etc.), and the environmental, political, cultural and social dimensions, and which also try to point out the vulnerabilities. Urbanised areas are at the intersection of issues concerning housing, mobility and more generally, living comfortably together. Cities, which account for 70% of energy consumption in Europe, also contribute greatly to the greenhouse effect and to pressure on the environment. Conversely, they are also sensitive to environmental pollution and the consequences of global change. The other major challenges concern building and transport performance, the organisation of urban systems promoting easy, efficient and fair access to the resources and services, the emergence of the digital society to guide, develop and promote sustainable uses of transport and manage the town more intelligently, and the continuity and adaptation of infrastructures and networks to existing and future needs.

Work developed in this framework must meet several goals:

- Build new knowledge on energy efficiency, environmental impacts and quality of use (comfort, air quality, noise, security, etc.), for the components (vehicles, buildings, etc.) and at different scales (blocks, districts, cities, networks of cities), also examining the interactions between these criteria and these scales;
- Develop modelling and simulation of the phenomena, to support design, aid in decision making and performance assessment;

- Assist in developing a methodological and technological proposition to build, renovate and adapt to the new energy and environmental requirements, but also to use the existing heritage and more efficiently manage the various elements of the urban and transport systems, particularly involving the user.

This societal challenge includes part of the thematic programmes in the 2011-2013 cycle ‘Sustainable Cities and Buildings’, ‘Sustainable Transport and Mobility’ and ‘Changing societies’, and the SIMI 3, 9 and SHS 1 and 2 in the blue-sky “Blanc” programme.

### 3.6.1 Research theme: Sustainable urban systems

As cities are complex systems, integrated multi-sectorial and cross-disciplinary approaches are necessary to better understand the way urban systems evolve, at different time and space scales. Contributions from the information and communication technologies, modelling and intelligent networks to production of the city and the urban services should come under multidisciplinary research, as should the impact of the intelligent city on the city-dwellers’ habits and on the urban metabolism.

**Urban metabolism and territorial ecology.** Cities consume large quantities of materials, food products and energy, part of which they discharge in the form of emissions into the environment. Greater understanding is necessary of the processes of this urban metabolism, which is an eminently multi-disciplinary field of research, because of the political, economic, spatial, technological, social and cultural dimensions, closely interwoven with the natural dimension. The underlying issues concern not only understanding how cities function and interact with the biosphere, but also raise the questions of foresight planning and action – sealing off the flows, urban, agricultural and industrial symbioses, relations between inequality and vulnerability and resilience of the districts, short circuits, conflicts in use of space, etc.

**Biodiversity and urban ecosystems.** Although we are beginning to understand some of the roles played by nature in cities, work to produce new knowledge about how urban socio-ecosystems function is needed to form the base of an urban ecological engineering science. These natural ecosystems provide a number of services: supply, regulation and services of a social nature. It is also essential to find approaches to assess the ecosystem services, in relation to the question of the use of soil (eco-balance, social applications, help in adapting to climate change, etc.). A multi-scale approach would make it possible to address the inequality of access to the ecosystem services, segregation and inequalities of space, and to look for solutions to the problem.

**Urban adaptation and resilience.** The vulnerability of towns has many facets: technological, economic, social and environmental. Study of urban risks and vulnerability must consider not only risks of disasters (sudden, unexpected events), but also the gradual changes likely to affect the urban system (for example the slow impacts of climate change). It is important to quantify the fragility of urban systems and also to develop approaches to assess their vulnerability, which integrate the interactions between the various components of these systems, at different time and space scales, their evolutions, and also the interfaces with their environment. An important issue, both for knowledge and for operational aims, concerns building resilience and adaptation strategies. It would be especially important to study the development of an adaptability engineering science, especially for the built heritage (buildings, networks, transport infrastructures, etc.).

**Urban practices and sustainability.** City-dwellers’ habits are gradually changing, especially under the effect of an “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 representation and practices which often remain resource-intensive. This holds true for mobility habits, with strong links to residential choices, the location of economic activities and the layout of transport networks. Knowledge, understanding and regulation of tensions inherent to the advent of sustainable practices therefore determine a fully-fledged area of research. Echoing questions of well-being and quality of life, research on urban sustainability calls for a convergence of studies on the transformations in urban ways of life and the relations that societies have with their environment.

**Urbanisation, spatialisation, urban morphologies and dynamics.** The urban dynamics, transitions, interactions between short and long timescale and between local and global scale are still relatively unfamiliar, although they are at the centre of urban sustainability issues. We need to better understand the factors that make towns evolve (growth and decline, etc.) and the dynamics that help to consolidate or weaken town systems, and help to renew relations between large cities, medium-sized towns and rural areas, once again examining the locations of populations and economic activities (town centres, suburbs, rural areas, etc.). In this dynamic context, it is also important to re-examine the connections between urban forms, the organisation of the urban fabric, the range of transport services and infrastructures, mobility and impacts on the environment and on social cohesion. Research must shed light on the controversies concerning densification, compactness and mixes (either functional, social or generational), multipolarity, etc. in building urban sustainability. Another important issue in the evolution of urban societies is fair access to urban resources and services, in an increasing context of socio-territorial fragmentation and segregation.

### 3.6.2 Research theme: From buildings to sustainable built-up living environments

**From buildings to positive energy, low environmental impact blocks.** Although the Grenelle law requires that by 2020 all new buildings must use positive energy, the definitions and methods for generalising this remain to be specified. Research questions are still open as to the right space and time scales to address positive energy. At the same time, considerable changes to the regulations are underway in the construction field: obligations now concern the outcome, not the means. Although this change allows for greater freedom of choice and should encourage technical and architectural innovation, it will also require methodologies and instruments for physical measurements (particularly for energy audits and performance monitoring).

A lot of tools and models for designing buildings are based on hypotheses that the new energy performance targets render obsolete, particularly because secondary, hitherto ignored phenomena have now become significant. It is important to review these tools intended for design, construction and renovation (digital models). They must integrate questions not only of energy but also of health (air quality, acoustics, etc.), comfort (multi-physical approaches) and the interactions and retroactions between technical systems and users. All this requires better knowledge of behaviours, qualities and values in use and closer cooperation between social sciences and humanities and engineering science the better to anticipate the actual performance of the buildings.

**Sustainable construction and management of built heritage and infrastructure.** In addition to measuring, instrumentation and modelling tools, it is important to rethink solutions for construction and maintenance, inspection and management, optimisation of use, materials, low-cost, high performance renovation technologies and methods of intervention intended for buildings, transport infrastructure and networks in the sustainable development perspective, taking into account the constraints of future scarcity, the potential impacts of climate or demographic change, etc. and covering the whole lifecycle. To supplement the work on technical, economic and environmental optimisation, the research must also contribute to the development of innovations aimed at strengthening resilience and capacities for 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 guided by use.

An important area of research concerns economic models and way these innovations are disseminated and adopted by stakeholders in the construction industry and by the users, particularly in the building and infrastructure renovation industry. It is also necessary to design innovations that are easier to adopt, and which perform well in a great variety of uses, taking into account, right from the beginning, the practices and values of the users.

**Links between buildings, infrastructure and transport.** The emergence of decentralised energy production, in the buildings themselves, and also transport infrastructures, and individual transport with greater use of electricity leads us to rethink the technological relationships and the energy exchanges possible between the different components of the buildings, which are urban systems in their own right, transport vehicles and infrastructure and the economic models that will help to develop these interconnections.

### 3.6.3 Research theme: Sustainable mobility and transport systems

Although the transport of people and goods (by road, rail, river and sea, etc.) meets strong society demands, it also consumes large quantities of fossil energy, with severe environmental and health impacts. There is still much room for improvement to reduce local pollutant and greenhouse gas emissions, increase energy efficiency, safety, the quality of the services and affordability. Promoting sustainable mobility supposes a systemic and multi-disciplinary approach, incorporating technological innovations, new services and new practices.

**Mobility and transport systems.** The energy and ecology transition urges us to rethink globally and to make more efficient transport systems by using multi-modal, interoperable systems, improving the way they are run and improving information exchange (ambient intelligence), for transport of people and of goods, at all space scales (urban, rural, interurban...).

It is also based on understanding the dynamics of mobility and uses and on the development of intelligent mobility services aiming to ensure continuity in transport systems. Individual mobility cannot be separated from housing, space planning and the organisation of activities, which depend on very different time and space scales. Questions of mobility can be addressed by engineering sciences but they also call for social sciences and humanities approaches, especially for those disciplines based on the study of spatial dynamics and territorial development.

Sustainable mobility also involves making transport systems more efficient, particularly by providing safer and more secure modes of transport to reduce fatal accidents and insecurity, developing vehicles better suited to the demand, more affordable and better designed, especially for people with disabilities, and reliable vehicles and parts – particularly electronics and information and communication technology – of transport systems.

Developing fully automatic vehicles is one way to improve safety and will be dealt with in its own specific “Challenge competition” (VIVIANES).

**Vehicles with high energy efficiency and low environmental impact.** As a large part of mobility will continue to involve vehicles, reducing environmental impacts of transport also largely requires removing the technological stumbling blocks, which will allow for the generalisation of transport vehicles, individual or collective and commercial, with very low greenhouse gas emissions (for example, for privately-owned vehicles the goal is to produce hybrid cars that use less than 2l of fossil fuel per 100km and electric vehicles). This development will come about with research work mainly focusing on very high energy yield power chains emitting low levels of pollutants, depollution systems, the use of fuels that give off fewer greenhouse gas emissions than petroleum (including

biofuels) and more general approaches such as reducing the weight of vehicles by using lighter materials and developing active security solutions, and by optimum energy management adapted to the environment (communicative vehicles). Work on batteries, recharging facilities, fuel cells and on-board hydrogen storage, low-power electronics and high-efficiency electric machines are dealt with in the “Clean, secure and efficient energy” challenge, section 3.2, taking into account the specifications applying to transport applications.

#### 3.6.4 “Challenge competitions”

There will be two competitions organised (subject to agreement by the partners) in this societal challenge. Specific procedures will apply, so we advise applicants consult the calendar of calls for proposals on the ANR website.

**“Challenge competition” 1: Sharing energy in the city in 2030** in partnership with EDF R&D (subject to agreement). This is an international competition combining artistic creation, design and scientific research. The innovations put forward will be examined for two concepts: the value of energy exchange and the improvement in group living conditions.

**“Challenge competition” 2: VIVIANES** (Intelligent Vehicles in the City - Independent Navigation and Safety). This competition, initiated in partnership with the IEED VEDECOM, the IGN and the DGA, aims to encourage the development of low-cost solutions which will be evaluated and compared in ambitious contests.

### 3.7 Information and communication society

The new information and communication technologies have a profound impact on our society. Information, services and applications are available at all times and in all places. New usages and massive data creation are significantly changing our lives and behaviour. Digital technology brings scientific and technological excellence but it also introduces a threefold social issue: first of all an economical issue, as it is a major growth segment in Europe (5.9% of the GDP), a national sovereignty issue since data represents tomorrow’s political power, and a societal issue as digital technology is more and more frequently used as a social and cultural vehicle.

The “Information and communication society” challenge has two main goals: using digital technology for the benefit of society, and designing and developing tomorrow’s digital technology through innovative concepts, methods and tools. The most important research themes for 2014 are 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 finally digital society security.

The challenge applies to the whole innovation chain, from the most fundamental research up to the design and development of pre-industrial tools and methods.

This societal challenge covers the former ANR thematic programmes (CONTINT, MN, INFRA, INS, P2N, LEARNING) and blue-sky Blanc programme (SIMI1, 2, 3, 4 and 10; SHS1, 2, 3) in the 2011-2013 cycle.
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### 3.7.1 Digital Society

Here we mean digital technology for the benefit of society. We welcome multidisciplinary projects taking up several challenges, especially in the “Innovative, inclusive and adaptive societies” challenge.

Digital technology plays an increasingly important role in everyday life, taking over private, professional, intimate and social spheres. In this context, five fields of application take priority: (1) health, longevity and autonomy, (2) smart cities, mobility and transport, (3) energy and smart grids, (4) social integration and bonds, particularly in the professional sphere, (5) global security. The interaction of digital technology with the fields of application is addressed in the challenges “Efficient resource management and adaptation to climate change”, “Clean, secure and efficient energy”, “Industrial renewal”, “Health and well-being”, “Mobility and sustainable urban systems”, “Innovative, inclusive and adaptive societies” and “Freedom and security of Europe, its citizens and its residents”.

#### 3.7.1.1 Research theme: Training and education

Digital tools have completely changed the fundamental aspects of education, i.e. the reference text and the teacher who possesses the knowledge. Text content is becoming richer, is more often multimedia, and is accessible at all times, by everyone everywhere, incorporating cultural and economic issues of content management. New methods using the real and virtual worlds facilitate and customise access to knowledge by using simulations or fun approaches (serious games), with a reappraisal of the teacher’s role. Research in this field will generate a radically new approach to sharing knowledge and practices. It will also lead to a fine-tuned adaptation to the needs of society, companies and individuals, the centres of interest, and their cognitive and sensorimotor skills.

Educational issues are of four types: technological (development and deployment of platforms, managing content, multimodal interfaces), methodological (educational engineering, designing content, evaluating what has been learnt), economic (cost, return on investment), and societal (right to access to knowledge, individual recognition, scientific and technological intelligence). The challenge will support projects addressing one or more of these issues. Emphasis will be on training in digital technology and ICT in particular, starting at a young age, and on developing a digital culture in teachers. Educational engineering as a method that includes cross-disciplinary competences (including cognitive sciences and social sciences and humanities) to invent and evaluate new forms of knowledge acquisition must be the centre of e-learning. Unifying, developmental projects based on MOOCs (Massive Open Online Courses) will be encouraged, providing of course that they include a longitudinal evaluative dimension giving greater insight into the possible effects of these methods on educational processes.

This research theme supplements the “Education and learning” theme in the “Innovative, inclusive and adaptive societies” challenge. Multidisciplinary projects covering the two themes are strongly encouraged.

#### 3.7.1.2 Research theme: Digital and technological studies of the intellect

This research theme concerns the impact of digital science on knowledge and how it is created, protected and passed on. Digital technologies have created a new “mnemonic milieu”, in the sense of a milieu to retain collective memory. Knowledge is a collective memory structured by conceptual models implemented by those who share it (and who therefore constitute peer communities), and

this knowledge is necessarily influenced by the mnemonic milieu which imposes constraints and makes a form of control possible. The omnipresence of digital technology therefore engenders a transformation of all forms of knowledge. This digital *episteme* must be analysed for itself in intrinsically cross-disciplinary studies.

In this field the digital humanities have already begun studies which should be part of the wider field of digital studies based on close cooperation between the formal sciences, human and social sciences and digital science and technology. The digital *episteme* leads us to reformulate throughout the entire academic and scientific field the fundamental questions of classification, categorisation, indexation, terminology, ontologies and syntaxes. This requires very different themes for the relations between delegating to automatic processes and interpretation: the algorithm processing of scientific data is a form of automated categorisation.

The challenge calls for studies which will contribute to building an environment of cross-disciplinary epistemological research on questions raised by the effects of the digital mnemonic milieu on the conditions and nature of the scientific research itself (epistemological questions raised by Big Science and the “computational turn”). These studies can be beneficial in facilitating developments of digital intellectual and collaborative technologies intended for the academic and scientific world.

This theme is cross-cutting with the “Culture and heritage” theme in the “Innovative, inclusive and adaptive societies” challenge.

### **3.7.1.3 Research theme: Digital technology at the service of the arts, heritage, cultural and publishing industries**

Like theoretical and practical knowledge, art, culture and leisure items are constantly changing, with new cultural practices revolving around digital, multimedia and multilingual content. These practices foster the emergence of new creative dimensions, new forms of expression, narrative, multimedia writing and transmedia content, based on joint creations and sharing, and on mobile or immersive devices.

Similarly, the priority should be on mobilising research to transform the publishing process, making it compatible with the new forms of writing, production, publication, dissemination, contributory publishing, and the enrichment and consumption of digital content linked to cultural and publishing industries, with all the related issues of rights of use and exploitation.

This research theme is complementary to the “Culture and heritage” theme of the “Innovative, inclusive and adaptive societies” challenge. Multidisciplinary projects relating to both challenges are eligible.

## **3.7.2 Science and digital technologies**

### **3.7.2.1 Research theme: The fundamentals of digital technology**

The challenge calls upon basic research striving for excellence and breakthrough developments in computer science, systems and communication science and engineering and mathematics.

Computer science includes information processing systems in the broadest sense, all research on processors, machines and networks to process this information, scientific computing, “smart” systems that can help decision-making and interact with humans or other systems, or even replace

humans for certain tasks. These systems come in different scales: circuits, embedded systems, computers, clusters, networks of such machines, the internet etc.

Systems and communication science and engineering include all basic research ranging from electronics to systems through photonics, nanoscience, automation, communications, computer-integrated manufacturing, robotics, signal processing and digital content (optics, infrared, electromagnetics, acoustics, images, video, etc.). This area is based on: modelling and analysis; the information chain (sensor-acquisition-conditioning); new sensors and actuators (especially on micro and nano scales); information processing; data reproduction. Lastly, these devices should be able to build networks, whether to communicate, to connect sensors/actuators or for robots to communicate while including humans in the interaction. The major challenges concern heterogeneity (models and data), the transition to scale, energy consumption, diagnosis, the distributed and adaptive aspects of the devices, the resilience of devices, etc.

Mathematical tools are absolutely fundamental to the design of information processing and communication systems. The areas concerned are numerical analysis, dynamic systems, probability and statistics, control theory and optimisation as well as logic, algebra and geometry. This challenge is wide open to basic research in areas of mathematics whose direct application in digital technology has yet to be demonstrated.

### **3.7.2.2 Research theme: Software technology and science**

Software technologies provide tools both to create new virtual learning technologies and a more reliable and secure digital process. They are used in computing and control equipment, structure data processing algorithms, and provide intelligence to tools to interface with the physical and human world. They provide the basis for coding the information to be transmitted and the architectures required for using electronic components. Whether visible or embedded and hidden, software is present in every part of our society. It is used everywhere by individuals in their daily tasks, communication, research and transactions, and drives their machines.

The challenge supports research in programming and specification languages at various levels of abstraction; architecture and coding techniques and styles; optimised compiling of programmes between languages at decreasing levels of abstraction, down to the internal languages of sequential or parallel machines; software infrastructure running on embedded hardware, real or virtual dedicated machines and equipment; debugging support through performance display and analysis; automatic analysis tools for programme safety verification (no bugs) and security verification (restricted access, tamper resistance).

### **3.7.2.3 Research theme: Digital society security**

The strategic issues of digital security are linked to the social, societal and economic considerations representative of societies in their increasing move towards paperless activities. These changes are emerging in an environment where security is essential to the functioning of digital infrastructures vital for society, the protection of increasingly open information systems, wider user confidence in the systems available, especially with the globalisation of mobile devices, the increasing computerisation of communication and cultural content, the success of social networks and the development of cloud computing. This results in a number of key priorities and scientific challenges: critical infrastructure protection, cybersecurity and related strategies, cloud security, outsourced data security, security of cultural content, protection of privacy, security of identification systems,

component and circuit security, preponderant software system verification and resilience, and cryptography.

This theme is also linked to the societal challenge of “Freedom and security of Europe, its citizens and its residents”, which addresses the issue of security in an integrative capacity and as applied to social issues (section 3.9).

#### **3.7.2.4 Research theme: Interactions between physical, human and digital worlds**

At the heart of an interactional change, humans must expect a more extensive connection to the physical and digital worlds “captured” by linked smart and communicating objects that enable certain actions.

Improving interaction with the digital world, designing new interactive objects and services, and creating better tools for developing these systems are major issues requiring the user to be integrated from the design stage and the multidisciplinary dimension of Human-Machine interaction to be considered throughout the entire process of future digital product creations: research, training and production. It is through this challenge, combining science, technology and design, that progress in research will have a strong impact: multimodal interfaces combining gestures, speech, context-aware dimension and the psycho-physiological state of the user; hybridisation between the real world and the digital world, blurring the boundaries between physical and virtual objects; collaborative services to capitalise on collective intelligence; professional and domestic robotics to perform a growing number of daily tasks.

These developments will in turn be based on a user-oriented approach, on increasingly open access to data and massive data, on the increasing interoperability of digital infrastructures, and on the consideration of security and privacy issues as far as users are concerned. The nature and social impact of strong pressure for “open data” should be considered, particularly in connection with the general demand for “right to information”.

Through research on interfaces, this research theme also addresses interaction in its relation with the field of content creation, indexing and access, not to mention multilingual and cross-lingual dimensions. It is important to develop technological solutions adapted to new means of content consumption in terms of mobility, multi-screen use, interactivity, but also compatible with new requirements in terms of access to information, relevance, queries, adaptive visualisation, and dynamic knowledge discovery.

This research theme therefore addresses issues of content and knowledge aggregation, annotation, deep indexing, semantic processing and analysis, knowledge modelling and representation.

#### **3.7.2.5 Research theme: Massive data, knowledge, decisions, HPC and digital simulation**

In many scientific fields (genomics, environment, climate, plasma physics, sciences of the universe, agrosocieties, materials, sociology, etc.), technologies and socio-economic fields (smart grid, nuclear, aerospace, petroleum, pharmaceutical, manufacturing, digital, service industries, etc.) the use of large volumes of data now available and the utilisation of HPC capacities have produced a *data revolution*. In this research theme, multidisciplinary proposals are expected (involving computer scientist, analyst, data scientist, mathematician, statistician, etc.), with the emergence of an interdisciplinary community for data science. There is strong interaction with all nine other challenges.

To seize these significant opportunities for growth and employment, the challenge aims to address certain barriers:

- The ability to deploy end to end data development processes: collection and integration of multi-source and incomplete data; automating the extraction of knowledge, repositories and domain ontologies, semantic interpretation of unstructured data; hardware and software infrastructure security, protection of privacy and user trust.
- The ability to interoperate fields (data, knowledge extraction, decision support, intensive computation and simulation): developing high performance computing and massive cloud storage infrastructures for scalability; large-scale deployment of data analysis tools (data mining, text mining, visualisation); controlling complex systems; Big Data and simulation; proposed platforms for experimentation and testing, accessible to research teams and companies.
- HPC: developing software and hardware solutions in synergy with the application areas (co-design) to bring together massive, hierarchical and heterogeneous parallelism (computing capacity and network, 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, parallelism hierarchy and data management must be integrated into the design of these methods. This work should be coordinated with European projects and initiatives, particularly those addressing European Technology Platform ETP4HPC and HPC PRACE infrastructures.

#### **3.7.2.6 Research theme: High performance digital networks**

The new era of communications the society is entering will be characterised by a significant acceleration in the deployment and use of disruptive services and applications. Tomorrow's services and applications will require a better integration of the various components of the value chain (communication devices, personal terminals/devices, high-speed networks, cloud computing, content distribution and management systems, services, etc.). Hardware and software infrastructures for future networks and systems will allow billions of devices to communicate and share computing and storage capacities. Network technologies and architectures will have to evolve, not only in terms of capacity but also in terms of functionalities to support new services and applications. This results in a number of scientific challenges to address in this theme:

- Increased capacity in the networks in a context of widespread mobility in the access network
- Future network and service architectures that are flexible, efficient and reliable
- New connected intelligent objects
- Network and service security
- System integration and deployment
- New business models
- Governance, regulation, neutrality and standardisation management
- Managing energy consumption and radiation control

#### **3.7.2.7 Research theme: Science and technologies for nanoelectronic and nanophotonic components**

The national strategy is based on early research enabling technological breakthroughs, technological research that must include a strong component of simulation and design, technological capabilities at the highest international level and more extensive technology transfer through integrative research



projects. To ensure an effective development process, upstream platforms should enable the realisation of innovative academic projects from laboratories; technological integration platforms need to provide technology demonstrators and meet the needs of industry, especially small and micro businesses.

The challenge will support basic research in nanotechnology (nanoelectronics, nanophotonics, spintronics, quantum engineering), research in micro and nanoelectronics components (miniaturisation, low energy consumption, memory, substitution of rare materials, etc.), prioritising solutions to achieve high-performance and low energy electronic circuits, meeting the green IT goal, as in the FD-SOI sector, new components (transistors, memory, lasers, etc.) using new materials (III-V, graphene, metal oxides, etc.), components and systems for nanophotonics, opto-electronics, heterogeneous integration for the development of specific components and integrated multi-function sensors (including their potential for the environment and detection capabilities in biology/health), the design of disruptive devices, sensors including imagers combining nanoelectronics and nanophotonics, and actuators, at the base of interfaces with the real world and humans. These priorities will focus on the critical components that are: heterogeneous 3D integration, co-design, characterisation, modelling and testing.

### 3.7.3 “Challenge competitions”

Two competitions will be introduced in the context of this societal challenge, subject to agreement by the partners. They will be covered by specific call procedures. We recommend that you consult the calendar of calls for proposals on the ANR website.

**The VIVIANES** (Intelligent City Vehicles - Autonomous Navigation and Safety) “**Challenge competition**” in partnership with the IEED’s VEDECOM and the French defence procurement agency DGA (subject to agreement): in addition to providing driving aids, the autonomous navigation functions appear to be a natural development for motor vehicles in urban infrastructures of the future. The VIVIANES competition aims to encourage the development of low-cost solutions that will be evaluated and compared in ambitious contests.

**The ARGOS** (Autonomous Robots for Gas and Oil Sites) “**Challenge competition**” in partnership with Total (subject to agreement): many industrial sites located in harsh or dangerous environments operate on an essentially automated basis. However, routine activities (monitoring) or very dangerous activities (interventions when there is an incident) are still carried out by humans. The ARGOS competition is open to international contestants, and tests revolve around land and offshore production issues.

### 3.7.4 International initiatives

Bilateral partnerships are envisaged as part of this societal challenge. The appendices should be consulted for each country, describing the terms and thematic or disciplinary fields concerned by these bilateral partnerships.

In addition, several European and international initiatives are foreseen in the form of specific calls. The calendar of international calls for proposals is available on the ANR website.

## 3.8 Innovative, inclusive and adaptive societies

Social Sciences and Humanities (SSH), which cover the vast area of human activity, in interaction with other sciences, make a major contribution to the complex analyses of societal issues, and are at the root of new critical questions, regarding both societies themselves, in their various dimensions, and individuals' relation to developments in these societies. The extreme diversity and plurality of the SSH means that they can be used in their entirety for the "Innovative, inclusive and adaptive societies" challenge.

SSH research in this challenge must be based on a strong disciplinary foundation, a condition for achieving productive interdisciplinarity, both within the disciplines of SSH and in symbiosis with other disciplines. The development of sustainable national and international disciplinary and interdisciplinary coordination networks also plays an important part in structuring the field to meet this challenge.

Therefore, all mono-disciplinary and multi-disciplinary, fundamental or more finalised proposals are eligible (particularly in support of requests made by institutional or social partners).

In keeping with the guidelines of the strategic agendas *Horizon 2020* and *France Europe 2020*, and in close connection with the proposals of the thematic research Alliance ATHENA (Contribution to Horizon 2020. Social Sciences and Humanities and ANR Programming 2014. Proposals), the ANR 2014 Work Programme for this societal challenge establishes four scientific priorities.

In addition, several societal challenges under the 2014 Work Programme cover other research subjects and paths requiring SSH research, especially in the following challenges: "Efficient resource management and adaptation to climate change", "Industrial renewal", "Health and well-being", "Mobility and sustainable urban systems" and "Information and communication society".

The disciplinary fields under this societal challenge are those of the former Blanc and Young Researcher programmes, of SSH Evaluation panels 1, 2 and 3. It also covers the topics supported by the programmes "Innovative societies", "Changing cultures" and "Learning" in the 2011-2013 cycle.

### 3.8.1 Research theme: Innovations

The issues of socio-cultural changes, political transformations and technological innovations are central to designing and building a society in which all individuals feel included. Innovations lead to profound changes in the ways objects are produced, professional contexts are structured, spaces and housing are organised, knowledge is acquired, and institutions and businesses are governed. In addition, they change consumer habits, but greater still individuals' relation to time, to things, to others, to their own body, and to institutions (government, law, schools, etc.).

Innovation is a key issue for our society given the questions raised by globalisation and complex interdependences, including the emergence of global (economic, environmental, health) risks, limited natural resources and waning biodiversity. Ageing populations, changing urban demographic trends (decrease in population in some cases, rampant growth in others), the development of national, cultural and socio-economic separatism, and competition from emerging countries in international markets, all add to the need for innovation.

Research in this area is at the intersection of Social Sciences and Humanities approaches and the issues raised by other scientific disciplines. The combination of perspectives from economics, law,

psychology, sociology, architecture, urban planning, geography, political science, philosophy, history of technology, history of the arts and creative processes, will help to ascertain and analyse the adaptations and changes that individuals and organisations face.

With regard to the general innovation process, it will also be necessary to study its social preconditions (“a society of trust”): as such, we will focus on representations and typical patterns of hyper-aversion to risk and the various interpretations, in this context, of the principle of precaution.

Inequality and exclusion (whether social, economic, cultural, generational or regional) as far as innovation processes are concerned call for further research. Representation of changes and the terms of their acceptance or rejection should be studied through psychology, sociology, anthropology, law and economics. These studies would be facilitated by being based on major social science data infrastructures such as the ESS (European Social Survey) or SHARE (Survey on Health, Ageing and Retirement in Europe) and require theoretical analyses and new conceptual standards.

With the emergence of the information and knowledge society, and therefore with faster information flow speeds, increased storage and processing capacities, and the proliferation of networks, relation to time and space is changing and everyday habits and decision-making processes are now profoundly put into question. Such findings resonate with the questions raised in the challenge “The information and communication society”.

The acute issues raised by the socio-economic developments and technological innovations include those of urban development and changes in work habits. The former require coordination with the ‘Mobility and sustainable urban systems’ challenge and the latter with the ‘Industrial renewal’ and ‘Health and well-being’ challenges.

Research on innovation must also be placed at the intersection of several fields (ICT, nanotechnology, health, energy, environment, industrial and agricultural production, materials) and in a systematic interdisciplinary perspective. This is why multidisciplinary proposals and public-private partnerships are strongly sought.

### **Cross-cutting themes**

Several themes under the scientific priority “Innovations” are cross-cutting with other challenges and require a high level of coordination or joint programming, including:

- **demographic and structural changes in the population**, with the “Efficient resource management and adaptation to climate change” and “Health and well-being” challenges;
- **development of environmental, health and social risks**, with the “Efficient resource management and adaptation to climate change”, “Industrial renewal” and “Health and well-being” challenges;
- **inequalities in sustainable development** with the “Efficient resource management and adaptation to climate change”, “Health and well-being” and “Mobility and sustainable urban systems” challenges;
- **transformations in work habits and in the workplace**, with the “Industrial renewal” and “Health and well-being” challenges;
- **transformation to cities and innovations in housing**, with the “Mobility and sustainable urban systems” challenge;
- **proliferation of communications and increase in information**, with the “Information and communication society” challenge.

### 3.8.2 Research theme: Social dimensions of the digital turn

This research theme is specifically aimed at eliciting contributions from SSH to study contemporary forms of the digital society. ICT dissemination should indeed also be studied in connection with the organisation of economic activities, informational or political practices, cultural exchange, learning processes and forms of communication. The idea is therefore to examine the changes associated with ICT (innovation, strengthening of traditional power struggles, shifts in decision-making locations, transformation in regions, evolution of man, etc.). The following in particular may be addressed:

- Changes in activity organisation models related to the dynamic and reconfiguration of ownership, living and work areas;
- Transformations to sociability, mobility and ways of living, whether in public places (stations, cafes, public transport, etc.) or in private spaces;
- Nature of the skills and practices (institutional, economic, cognitive, etc.) required or driven by the introduction of ICT;
- Impact of digital tools on cognitive development, on the emergence and development of written language communication and on the forms of individual and collective communication;
- New modes of knowledge production and information dissemination.

A huge amount of digital data is generated in all areas and there is growing pressure for all this data to be “open”. What are the real issues of this call for open data and what does this movement tell us about the characteristics of contemporary societies? Can we identify invariants in the way these processes are taking place? What forms of mediation (or remediation) are emerging in the public domain under the pressure for open data?

In addition to the technical issues of storage are the acute issues of the “right to information” and organising the free circulation of knowledge in a cross-linked world where knowledge, produced by a variety of people, is stored on a network and can be retrieved at any time.

### 3.8.3 Research theme: Education and learning

The existence and effectiveness of lifelong learning are essential for an innovative and adaptive society, and a factor conditioning integration within society.

New methods and more effective educational tools must be developed to help for a better acquisition of basic skills (reading, writing and arithmetic), and mastering of foreign languages or digital tools and concepts. Although the scientific literature on learning mechanisms has grown fast, leading to applications in the educational field, direct interaction between education science and cognitive science is still in the early stages. Projects integrating social sciences and humanities can provide a strong framework for such scientific interaction.

In addition, today, learning deficits are more easily distinguished (the different “dys”-word deficits), without considering only the intellectual factor. Again, it is appropriate for teaching methods to be adapted to the skills acquisition process, especially taking into account project teaching in arts and cultural education. Research has clearly shown the effect of different socio-cultural backgrounds on the chances of success. The mechanisms underlying the reproduction of inequalities can be explored

more precisely and meticulously at cognitive and institutional level. It is also desirable to develop comparative research on the transformation of education systems.

School dropout rates are a major issue for the “Innovative, inclusive and adaptive societies” challenge. It is important to conduct ambitious, ground-breaking research, particularly in sociology, psychology, socio-economics and sociolinguistics, to understand and to analyse the causes and effects, and to develop policy levers for effective prevention, intervention and compensation. More generally, the field of learning requires the development of large-scale research targeting systems designed to be rapidly operational. It also requires identifying the means for a fairer and more effective educational policy.

However, learning is not just about schools. Higher life expectancies and social and occupational mobility require greater research into lifelong learning. This research may relate to the capabilities of adults of varying ages, and to the contexts enabling new knowledge and skills to be acquired. This is a major challenge for our society, especially with regard to vocational training.

Access to new information and communication technologies is clearly a priority in this challenge as they radically change the very course of transmission of knowledge and skills. The use of new teaching and technological tools to support learning is ever growing, and their value and usefulness will depend on how well they are adapted to the teaching programmes and pupils. Research on the biological and cognitive foundations of learning also needs to be developed.

#### **Cross-cutting themes**

Several themes under the scientific priority “Education and learning” are cross-cutting with other challenges and require a high level of coordination or joint programming, including:

- **changes in children and learning**, with the “Health and well-being” challenge;
- **lifelong learning and occupational mobility**, with the “Work” research theme under the challenge “Industrial renewal” and with the “Health and well-being” challenge;
- **training and appropriation of new ICTs, transmission of knowledge and skills**, with the “Training and education” research theme under the “Information and communication society” challenge.

#### **3.8.4 Research theme: Creation, culture and heritage**

The study of culture and heritage is essential for the understanding of how our society is built, its diversity and how cultural, economic and political practices have developed. It is also important in order to facilitate the integration of its citizens. Through its many objects, this research is multidisciplinary: at the crossroads of all social and human sciences, it embraces a variety of approaches from the fields of archaeology, history, architecture, arts, geography, ethnography, law, economics, anthropology or sociology.

By subtracting certain objects from the utilitarian sphere and treating them differently, in particular handing them down from generation to generation, every society creates a cultural heritage and memories, constantly enriched and rebuilt, which link the future to the past.

The study and comparison of ancient and modern cultures, literature and languages, beliefs, religions and institutions help us understand how past and present societies have adapted and innovated. Multi-disciplinary international research on the ways in which culture is transferred, by whom (scientists, artists, professionals, translators, patrons) and by what means (institutional structures or otherwise), and on the changes in works and concepts, is also necessary.

Research on the conditions and processes of artistic and literary creation, on how it is received and disseminated, regardless of the era, should be encouraged with a new outlook. The same applies to emerging forms of artistic creation that require new scientific approaches. While data from the study of cultures and tangible, natural and intangible heritage can still have contemporary political relevance, research on non-European and far away heritage also enables us to take into consideration reciprocal fruitful influences. This contribution, both from the past and from far away heritage, is therefore essential in comprehending the diversity and complexity of our world and all its issues.

Therefore, comparative diachronic and synchronic studies are needed to better understand the central role of heritage in society's changes and innovations, but also to understand how heritage uses are transformed, or even "disherited", and their transmission, in every form. Relationships with heritage or heritage as a relationship, the comparative evolution of the concept of heritage in the different European and non-European countries, and how it is currently treated from a legal standpoint, are other focuses of study.

Heritage is also a collective and even a social memory. Its appropriation, born from being made aware and receptive to the multitude of its forms, is a factor for integration and the restructuring of the social fabric. The ways in which this memory is created and appropriated require multidisciplinary research resonating with the scientific priority "Education and Learning".

Heritage is not a reliquary monument to our past; it plays a part in regional dynamics and economic development and regeneration. The heritage industry is a major source of income and employment, which also contributes to the development of tourism and technological innovations used for the preservation and promotion of heritage. Furthermore, advanced research in materials science (natural and synthetic), based on public-private partnership initiatives, in collaboration with social and human science teams involved in the research, can contribute to industrial renewal.

Culture and heritage are entering the digital realm at full speed. Projects may involve the creation, enhancement, harmonisation, development or analysis of corpuses or data (regarding buildings, groups of buildings, landscapes, literary and historical texts, archives, statistics, or audio-visual materials, for example). Research dealing with a variety of corpuses is likely to lead to the search for new epistemological frameworks. One of the challenges of the future lies in the design of new digital tools for social and human science research, which relies heavily on corpuses and databases, but also, more broadly, in the availability of a wide collection of raw or enriched data. The scientific community in its strictest sense may not be the only one to benefit from it as it paves the way for citizen science.

Digital humanities, in particular, constitute a strategic sector, bearing rich prospects, and concern many SSH fields. This sector is likely to mobilise all areas of SSH: multiple communities arising from an interest in various cross-cutting practices, tools or objects (encoding textual sources, geographic information systems - for example new forms of displaying historical research results, made possible by geolocation techniques, lexicometry, digitisation of the cultural, scientific and technical heritage, web mapping, data mining, 3D reconstruction of monuments, oral archives, etc.) have emerged in recent years, and their networking is encouraged by the major research infrastructure HUMANUM. The projects will be part of the national and international landscape, as defined by the DARIAH ERIC. Project leaders are advised to ensure free access to online data and publications from funded projects.

The various aspects of artistic creation (e.g. digital and hyper-mediated arts and literature) and the study and promotion of culture and heritage increasingly involve the use of ICTs and partnerships with Social Sciences and Humanities teams. For these reasons, a multidisciplinary funding instrument (SSH and/or ICT and/or materials) under a public-private partnership will also be made available to cultural heritage project leaders.

### Cross-cutting themes

Several themes under the scientific priority “Culture and heritage” are cross-cutting with other challenges and require a high level of coordination or joint programming, including:

- **cultural economy and heritage**, with the “Industrial renewal” challenge;
- **heritage and materials science**, with the “Industrial renewal” challenge;
- **heritage and urban development**, with the “Mobility and sustainable urban systems” challenge;
- **artistic creation**, with the “Digital technology at the service of the arts, heritage, cultural and publishing industries” research theme under the “Information and communication society” challenge;
- **document scanning, creation of corpuses, access to “citizen science”**, with the “Digital and technological studies of the intellect” research theme of the “Information and communication society” challenge.

### 3.8.5 Research theme: Law, democracy, governance and new standards

Society is facing new challenges in terms of resource management, environmental and climate change, energy, industrial transformation, health and well-being, security, consideration for new consumer expectations, etc. bringing into question society’s methods of governance and regulation both on a national and supranational level.

These complex and interrelated challenges raise new expectations from the public, who are increasingly anxious to get involved in matters directly concerning them (their environment and lifestyle, their work, etc.), and to be able to influence political, cultural, legal and institutional frameworks. Hence, they question society’s methods of governance and regulation at local, national and supranational level.

This questioning calls for both new research and new standards, which will help, on the one hand, to take into account more effectively individual preferences, the well-being of society and environmental and societal impacts and, on the other, to create indicators to devise and introduce public policies.

Issues that may be considered in this context include:

- new forms of exercising power and political regulation;
- the plurality of contributors, the proliferation of bodies and scales, changes in relationships between public and private sector;
- changes in the relationships between economic and political power;
- changes in the status of law and governments, decision-making processes; the switching from the notion of government to that of governance or from that of public policy to public action; the transformation of soft law regulation models (softening of legal frameworks and their application procedures: arbitration, negotiation, mediation), particularly in relation to the interests of economic operators;
- the creation of new standards that would take into account more effectively individual preferences, the well-being of society, environmental and societal impacts and thus constitute indicators to formulate and assess public choice.

### Cross-cutting themes

Several themes under the scientific priority “Governance and new standards” are cross-cutting with other challenges and require a high level of coordination or joint programming, including:

- **governance and professional life** with the “Industrial renewal” and “Health and well-being” challenges;

- **new forms of public and collective action** with the “Food security and demographic challenges” and “Freedom and security of Europe, its citizens and its residents” challenges;
- **new theoretical standards and new conceptual frameworks** with the following challenges: “Industrial renewal”, “Health and well-being”, “Food security and demographic challenges”, and “Freedom and security of Europe, its citizens and its residents”.

### 3.8.6 International initiatives

Several international initiatives are likely to be introduced in connection with this societal challenge, particularly at European level. These initiatives will be covered by specific calls. We recommend that you consult the calendar of international calls for proposals on the agency's website.

## 3.9 Freedom and security of Europe, its citizens and its residents

The purpose of this societal challenge is to help provide new solutions for the major (societal, economic and sovereignty) challenge that is the security of French and European citizens and residents, in complementarity with the “Security” challenge of the future European framework programme Horizon 2020 and in keeping with the creation of a French industrial sector for security, and with national<sup>8</sup> and European<sup>9</sup> priorities.

The effectiveness of any security system is conditioned by the quality of the interaction between its technological, organisational and human components. The multidisciplinary approach is a key to the success of security research, which can involve various fields such as social and human sciences (sociology, ethnology, anthropology, management, economics, law, psychology, ergonomics, etc.), physics, life sciences, engineering sciences, chemistry, mathematics and IT.

This challenge aims to bring together the community of research and innovation in global security, to reach the efficiency and reliability targets demanded.

In addition to aiming for practical effectiveness and economic impacts, the challenge focuses especially on ethics, freedom and privacy. This is why the related issues (mainly legal and regulatory) should be taken into account very early on and whenever the projects require. To achieve these objectives, the research must involve both industrial and academic partners, as well as security stakeholders, whether public or private (prescribers and/or operators).

The challenge is divided into five areas:

- Protection of critical infrastructures and networks
- Freedom and protection of citizens and residents
- Resilience and crisis management
- Border security
- Cybersecurity

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<sup>8</sup> See White paper on National Security and Defence, April 29, 2013.

<sup>9</sup> See European security strategy, adopted by the European Council in 2003



Research projects will range from upstream (TRL 1)<sup>10</sup> to future applications (up to TRL 5). The main instrument of ANR funding to be used for this challenge is the Public-Private Partnership, but other instruments may be proposed if the nature and/or topic of the project warrant this (collaborative project, particularly in social and human sciences; research networks). In addition, international cooperation is expected, especially with Germany (BMBF, see below).

The themes of this societal challenge are a continuation of the thematic ANR programme 2011-2013: Concepts, Systems and Tools for Global Security.

### 3.9.1 **Research theme: Protection of critical infrastructures and networks (excluded from the generic call for proposals)**

This year, in keeping with the cooperation between ANR and the BMBF<sup>11</sup>, initiated in 2009, the “Protection of critical infrastructures and networks” research theme will be dealt with bilaterally between France and Germany, and will be covered by a specific call for proposals, to be announced at a later time.

This research theme focuses on the protection of transport infrastructures, production facilities, energy distribution networks (electricity, gas) and water distribution networks. Interdependencies among the most critical sectors (transport, energy, communications and water) and with other sectors must also be examined.

### 3.9.2 **Research theme: Freedom and protection of citizens and residents**

The protection of citizens and residents covers the fight against terrorism (including CBRNE) and serious crime, issues related to “minor” crimes and delinquency, but also the management of evidence (e.g. forensic investigation) and the protection of first responders. As part of this research theme, it is necessary to identify and prevent risks and threats as early as possible, then manage the consequences. This research theme also takes into account issues such as improving urban security, preventing violent radicalization of individuals or groups of individuals (greater understanding, origins, counter-measures) and “Privacy by Design” for new technologies (social networks, smart counters, video protection, etc.): the means of implementation, perception, and economic and societal impact of this concept.

### 3.9.3 **Research theme: Resilience and crisis management**

This research theme focuses on crisis management, regardless of the cause of the crisis (malicious acts including CBRNE, natural or accidental disasters, security implications of the economic crisis), giving rise to a disaster or sequence of disasters, according to the temporal phases of operational emergency (preparation, planning, emergency response and immediate repair) and resilience in the longer term. This research theme takes into account issues such as crisis management by way of a “pool of risks” approach, protecting populations and improving the resilience of the nation at all levels (material, organisational, human and societal resilience).

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<sup>10</sup> “Technology Readiness Level” scale for technological maturity ranging from 1 to 9

<sup>11</sup> German federal Ministry for Research and Education

A study of French overseas departments and communities (more regularly subjected to certain types of crises such as natural disasters) can be considered, to develop and validate potential solutions in other contexts.

#### 3.9.4 **Research theme: Border security**

This research theme concerns the security of sea, land and air borders and managing the security of human, material and immaterial circulation and interconnections. Issues such as the fight against trafficking and other illegal activities related to borders can be dealt with as part of this research theme.

#### 3.9.5 **Research theme: Cybersecurity**

The rise of 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, infrastructure and network operators, but also the public. Thus, projects should help to assess cybercrime threats and analyse their impacts (macro-economic or otherwise). They should also address methods, means and tools to fight against cybercrime targeting institutions, infrastructures, networks and individuals, such as fraud and computer tampering or hacking of information and communication systems and/or embedded systems, networks and infrastructures of vital importance.

Projects may be linked to the themes developed in the context of the “Information and communication society” challenge<sup>12</sup>, section 3.7.

#### 3.9.6 **International initiatives**

A bilateral agreement between ANR and the BMBF will be covered by a specific call for proposals, to be announced at a later time. It will focus on the “Protection of critical infrastructures and networks” research theme. We recommend that you consult the calendar of international calls for proposals on the agency's website.

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<sup>12</sup> The security of embedded systems and/or the security of information systems come under the scope of this challenge when they are part of the solutions to be implemented to meet the missions and capabilities targeted, in accordance with a system approach (medium TRL). Research focusing exclusively on software aspects, technological building blocks for the security of information systems or cryptography are more compatible with the “Information and communication society” challenge (low TRL).

## 4 The “At the frontiers of research” component

It is by going beyond the limits of our knowledge that societies progress, evolve and project towards the future. This thirst for knowledge, whether in the understanding of our world and the laws that govern it, or in the development of abstractions, has a major impact on our society, well beyond its own initial quest.

Rarely anticipated, this progress is based on scientific excellence, creativity and risk-taking. It exceeds the limits of any particular challenge or field of investigation. New scientific knowledge contributes to the evolution of society. This issue of knowledge in all disciplines is a key driver of progress, the implications of which are not always predictable, and is essential to address the societal issues of the future. It complements the processes dedicated to the nine major societal challenges, themselves open to basic research in their subject area.

That is why it has been decided to complete the processes dedicated to the nine major societal challenges with a specific component, open to all areas of science including those still emerging. This component focuses on two initiatives:

- The “All-knowledge challenge”, which aims to further support all scientific disciplines unrelated to societal challenges;
- Opening high-risk projects offering major scientific potential (OH Risk programme), which aims to stimulate scientific creativity in high-potential research areas, where the risk particularly lies in the absence of precedence in the existing literature.

### 4.1 A specific challenge: the “All-knowledge challenge”

Basic research is an essential part of progress in knowledge. At the heart of scientific excellence, it is a major force which, while addressing current issues, is the necessary fertile ground for the growth of new scientific or technological ideas.

This research, often exploratory, must involve all fields of knowledge to meet future challenges. The “All-knowledge challenge” is intended for research projects that do not appear to come under a societal challenge. It includes a comprehensive range of approaches, from theory to instrumentation. By no means exhaustive, research at the frontiers of knowledge in areas such as astrophysics, fundamental physics, particle physics, the structure and history of the Earth, chemistry or certain rare fields of humanities, certain components of fundamental biology, or fundamental mathematics are examples of projects outside the sphere of major societal challenges that can be funded.

The “All-knowledge challenge” therefore intends to complete the range of areas covered by funding by including projects in scientific fields not falling within the nine societal challenge categories. Funding instruments available for the “All-knowledge challenge” are the same as those for the major societal challenges, namely collaborative projects, public-private partnership projects, young researcher projects or research networks.

Relying on scientific excellence in a broad sense, this challenge pursues goals such as:

- progress in key issues of knowledge that structure and guide research, especially long-term research, in that it is ground-breaking, brings new concepts and paradigms, some of which will in turn lead to future application or industrial developments, which are essential to our country's industrial renewal;
- development of integrative approaches, particularly developing generic tools and/or methods to integrate different inputs, especially in an interdisciplinary context. These approaches, which have a vast application potential, which will emerge at some later time, warrant support in their own internal dynamics, which are inconspicuous in light of current societal issues.

This initiative is dealt with as part of the generic call for proposals concerning societal challenges. The selection process will be similar to and concurrent with the major societal challenges, and the additional criterion for the pre-selection of these projects is the non-relevance to one or more major societal challenges. Researchers wishing to submit a pre-proposal for the "All-knowledge challenge" are therefore advised to carefully read the descriptions of the major societal challenges to be able to prove that their work is outside the fields concerned.

## 4.2 OH Risk programme: a specific call for proposals dedicated to risk-taking for projects with high scientific potential

Developing creativity, encouraging boldness and risk-taking for projects with high scientific potential are among the priorities of the France-Europe 2020 Strategy. These objectives are present throughout the ANR's 2014 Work Programme and will be among the selection criteria for all funding mechanisms.

However, there is one category for very high-risk but high-potential projects, which requires a dedicated instrument and which has very special selection criteria. These are projects on preliminary research necessary to demonstrate the feasibility of a new concept or to develop a research area for which there is no real precedence in the scientific literature. Funding for this "proof of concept" category is essential to help start up bold research breaking away from traditional approaches, but these are seed projects which, by their very nature, cannot be selected based on traditional criteria of scientific excellence.

The selection process focuses on a single submission document which presents the proposed idea, explains why there is no real prior work to validate it and, if successful, the likely level of impact in terms of breakthroughs in scientific knowledge or technological developments (or even both).

The evaluation during the selection process will focus on three criteria: originality (no real precedence), potential impact and overall consistency. Limited capped funding will be provided for a period of 12 to 24 months, along with close monitoring to rapidly promote the potential discoveries and support unexpected new directions.

The "OH Risk" programme is covered by a specific call for proposals. We recommend that you consult the calendar of calls for proposals on the ANR website to check for the opening date.

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

This component is both cross-cutting with the other “Societal challenges” and “At the frontiers of research” components but also includes specific measures to enhance France's international attractiveness. Most societal challenges, and the “At the frontiers of research” component, are intended to support projects based on European and international consortia.

A European and international steering committee will coordinate initiatives on the basis of an overall vision and offer guidance to the ANR to define its European and international initiatives.

Several types of European and international initiatives are foreseen in the 2014 Work Programme:

- bilateral partnerships in the context of the generic call for proposals (all challenges, including the All-knowledge challenge)
- a specific partnership with Germany, Austria and Switzerland
- European and international calls for proposals (ERA-NETs, JPIs, bi- or multilateral calls)
- instruments to promote France's international attractiveness

### 5.1 Bilateral partnerships under the generic call for proposals

The ANR has established bilateral partnerships with its European counterparts (Germany, Austria, Switzerland, Luxembourg, Romania, etc.) and international counterparts (USA, Canada, China, Taiwan, Hong Kong, India, Brazil, etc.). The aim is to accelerate and extend cooperation between French researchers and the best European and international teams on key issues, promote partnerships with emerging countries on the global scientific scene in mutual areas of interest and to create transnational teams of excellence to be able to conduct and share research at the highest international level.

These partnerships are set up through the mutual opening of national calls for proposals in each country, a bilateral collaboration in which proposals are submitted to and evaluated by each agency in parallel. The agencies then coordinate on which projects to co-fund. These transnational projects compete with national projects. For 2014, these types of cooperation are implemented through the opening of the challenges (major societal challenges and All-knowledge challenge). The annexes per country, describing the terms and thematic or disciplinary fields concerned by these bilateral partnerships, must be consulted.

## 5.2 Building the ERA - Partnership with Germany, Austria and Switzerland

Building the European Research Area aims to create research funding areas without borders. To simplify and streamline the system, the ANR, DFG (Germany), FWF (Austria) and the SNSF (Switzerland) are in discussions to create a close partnership in 2014 covering all areas of science.

A “Lead Agency” process will be implemented in 2014 (subject to agreement). This type of interagency agreement is based on transparency and mutual trust and is a gauge of the ERA’s construction. Thus, a joint proposal is prepared by the teams and submitted to one agency (the lead agency), which is responsible for peer reviews, evaluation and 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 terms. For 2014, it is proposed that the DFG, FWF and SNSF conduct the evaluations. The appendices should be consulted for each country, describing the submission terms concerned by these bilateral partnerships.

Given the changes to the agency’s programme framework, all partnership terms must be made consistent by involving all national research operators, taking into account the process already initiated and the time required to set up negotiations.

## 5.3 European and international calls for proposals (ERA-NETs, JPIs, bi- or multilateral calls)

In connection with the various societal challenges, the ANR has developed multilateral partnerships with its European counterparts for European initiatives such as ERA-NETs or Joint Programming Initiatives (JPIs).

The conditions for participating in calls for proposals generated by the ERA-NETs and JPIs remain unchanged. We recommend that you consult the calendar of international calls for proposals on the ANR website.

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

## 5.4 France's international attractiveness programme

A special programme is proposed to enhance France's international attractiveness and attract brilliant junior or senior researchers with a very high potential. This programme is a development to the "Post-doctoral return" and "Chairs of excellence" programmes in 2011-2013. It targets brilliant junior or senior researchers based abroad whether they trained in France or abroad and, in the case of junior researchers, who are qualified to respond to calls from the ERC.

To this end, the ANR has created the "Hosting high-level researchers" funding instrument (see section 2.2.2), which plays a major part in France's scientific position abroad. This instrument is designed to help France's laboratories receive top foreign researchers for sustainable periods. The funding facilitates these initiatives by offering top scientists considerable means enabling them to come to stay in France for the long term.

This programme will be covered by a specific call for proposals. Researchers are invited to consult the ANR website.

The aim is for this programme to evolve into one open to co-funding by the European Commission under the COFUND instrument of "Horizon 2020" in order to replenish the ANR's funding of this initiative.

## 6 Economic impact of research and competitiveness

One of the ANR's duties is to promote the transfer of public research results to the industry. In addition to collaborative public-private partnership projects, which are one of the instruments funded in the "Societal challenges" component, the ANR has a series of programmes to boost partnerships between laboratories and companies according to various project research methods. This cross-cutting component combines three programmes that are covered by specific calls for proposals (Labcom and Industrial chairs).

- Labcom
- Industrial chairs
- Carnot institutes

### 6.1 Labcom programme

The programme to support the creation of laboratories shared by public research bodies and SMEs / intermediate-sized enterprises (Labcom) 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 assist these researchers to establish sustainable bilateral partnerships with companies, especially SMEs and intermediate-sized enterprises, since these relations are crucial to the innovation process. The transfer of results or knowledge from public research to this type of company can be a substantial driving force behind innovation, competitiveness and employment.

For this programme, which opened in 2013, the ANR has taken the necessary measures to enable high-speed decision-making and availability of funding. The agency has developed a streamlined peer selection process, based on a single panel, without mandatory use of external peer review. This selection is based on a simplified application and flat-rate funding of €300,000 from the public research laboratory, to enable the application to go through faster, swift funding and greater flexibility in the use of the research grant.

This programme is covered by a specific call for proposals accepting submissions on a continuous flow basis. We recommend that you consult the dedicated page<sup>13</sup> on the ANR website.

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<sup>13</sup><http://www.agence-nationale-recherche.fr/financer-votre-projet/impact-de-la-recherche-et-competitivite/laboratoires-communs/>



## 6.2 Industrial Chairs programme

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 providing the vision, methodologies and experience of private players to doctoral or post-doctoral researchers in high level public research laboratories
3. To help higher education and research institutions or public research organisations receive eminent French (expatriates or otherwise) or foreign lecturer-researchers

This programme involves a call for proposals in all research areas on topics defined from the outset by the public research laboratory(ies) together with their private partner(s). The project is led by an eminent scientist, future Chair, conducted in the public research laboratory(ies) and jointly funded by the ANR and the company(ies).

This initiative is covered by a specific call for proposals. Researchers are encouraged to consult the calendar of calls for proposals on ANR website.

## 6.3 Carnot programme

Since 2006, the Carnot label has been granted by the Ministry of Higher Education and Research to public research structures qualified as “Carnot Institutes” that undertake to focus on research partnerships. To accompany and support cooperation between institutes and private stakeholders an annual contribution calculated based on the partnership revenues is paid by the ANR to Carnot institutes. This contribution is devoted to developing scientific resources and professionalising partnerships with the industry. Last year, a total budget of €60 million was earmarked for the Carnot programme and allocated to all 34 institutes labelled in 2011.

To guarantee the success of the Carnot programme and ensure effective leverage, the “Carnot institute valorisation” 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. Other dedicated calls for proposals could follow.

# 7 Terms of submission and evaluation for the generic call for proposals

Projects relating to one of the major societal challenges or the “all-knowledge challenge”, whatever the funding envisaged (described in section 2), are to be submitted as part of the **generic call for proposals** as described below.

The submission and evaluation process for projects related to specific calls (especially in the case of ERA-NETs, JPIs, “Hosting high-level researchers” programme, ASTRID, Labcom or Industrial chairs programmes, etc.) will be covered by a document that will be available on the ANR website. We recommend that you consult the calendar of calls for proposals on the ANR website.

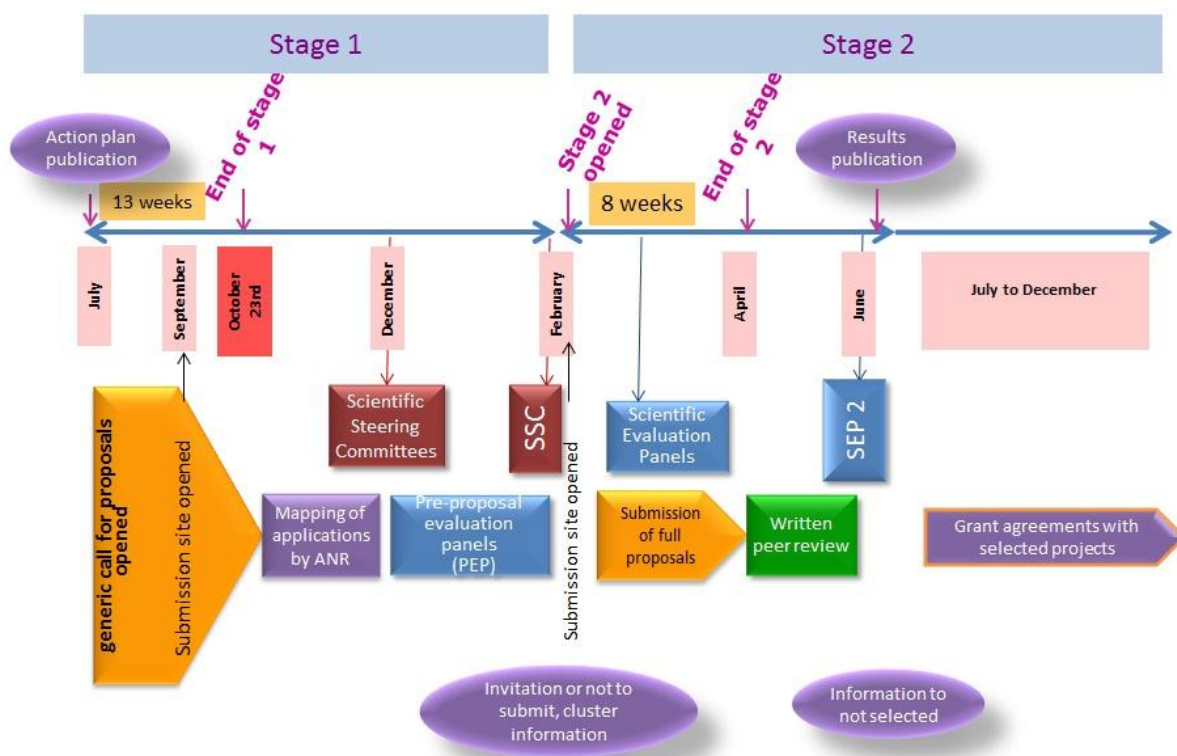
## 7.1 General description of the process

Projects submitted under the generic call for proposals will be selected in two stages. The first stage will aim to identify, on the basis of a short pre-proposal, 2,500-3,000 projects invited to submit in the second stage, all challenges (major societal challenges and “all-knowledge challenge”) combined. The second stage serves to select which projects to fund, on the basis of a full proposal.

The evaluation criteria for each stage are different. The criteria in the first stage focus mainly on the originality of the concept, relevance to terms of reference, and references from the project partner(s). The criteria for the second stage focus on scientific excellence, the quality of project’s construction and its potential impact.

The generic call for proposals page on the ANR website describes how to submit proposals on line.

The format and content of the pre-proposal and full proposal are described in the **Guide for Applicants** available on the ANR website.



**General outline of the two-step selection process**

## 7.2 Evaluation of pre-proposals

Pre-proposals are submitted on line on the submission site until the deadline for submission given on the ANR website. Instructions to prepare pre-proposals are available in the guide for applicants on the generic call page of the website.

Once the deadline for submission is reached, the competitiveness clusters are encouraged to issue opinions on pre-proposals requesting their support. These opinions will focus mainly on aspects directly related to the skills of these clusters: the removal of barriers, the potential opportunities and outlets, the impacts on businesses, industries and regions, and the consistency with the clusters' roadmaps and regional specialisations.

The ANR considers the eligibility of pre-proposals according to the criteria specified in section 7.2.1 and maps the applications. This mapping establishes a representation of pre-proposals received for each challenge, specifying interdependencies, taking into account research themes and sub-themes (as defined in section 3), funding instruments or the major fields related to the goals of the pre-proposals. This mapping is presented to the Scientific Steering Committee (SSC) for each of the major societal challenges and the "all-knowledge challenge", which validates it, along with the distribution of pre-proposals between members of the Pre-proposal Evaluation Panel (PEP). They specify the prioritisation of certain research themes and/or instruments for applications adapted to the issues of each challenge according to the criteria specified in section 7.2.2. Information on the support of competitiveness clusters is brought to the attention of the SSCs.

Each pre-proposal is sent to three PEP members for evaluation according to the criteria specified in section 7.2.2. PEP members rate each criterion. The opinions expressed by the competitiveness clusters are taken into account by PEP members.

Pre-proposals are ranked under each major societal challenge or the “all-knowledge challenge” based on the average ratings given by PEP members (see guide for applicants to the generic call for proposals describing the rating principle) and then harmonised by the board of SSC chairs. The result is sent to the SSCs, which validate the list of pre-proposals that may be followed by the preparation of a full proposal.

The ANR informs all the scientific coordinators of the result of this first stage. The scientific coordinators of selected pre-proposals are then invited to submit a full proposal.

### 7.2.1 Pre-proposal eligibility criteria

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

- The pre-proposal must be complete and in accordance with the format specified in the guide for applicants.
- The pre-proposal must meet the specific conditions of the funding instrument chosen (see section 2).

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

Pre-proposals are ineligible if several pre-proposals are submitted by the same scientific coordinator<sup>14</sup> in the context of this generic call for proposals.

### 7.2.2 Pre-proposal evaluation criteria

PEP members review the pre-proposals based on the three following evaluation criteria:

- Significance of scientific and technological objectives (importance of the subject, ability to generate results, potential for progress in the field, ambition, innovation, potential breakthroughs)
- Relevance and strategic nature of the project with regard to the orientation of the call (correspondence to societal challenges or lack thereof in the case of the “all-knowledge challenge”, benefits to society, how appropriate the chosen instrument is for the objectives, no crossover with H2020 or national calls for proposals)
- Consistency of the pre-proposal with the objectives of the project (applicant’s scientific references<sup>15</sup> or scientific references of “research organisation” partners and complementary

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<sup>14</sup> 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>

nature of the consortium<sup>16</sup>, whether the amount of funding requested corresponds to the project's objectives).

## 7.3 Evaluation of full proposals

Applicants invited to submit a full proposal have about eight weeks to prepare. Full proposals are submitted on line on the dedicated site until the deadline for submission given on the ANR website. Instructions to prepare full proposals are available in the guide for applicants and on the generic call page of the website.

Applicants may, if necessary, rely on the advice of competitiveness clusters to prepare full proposals. The competitiveness clusters must confirm their support by the full proposal submission deadline.

At the deadline for full proposal submission, the ANR checks their eligibility according to the criteria described in section 7.3.1, relying on the opinion of the members of the Scientific Evaluation Panel (SEP) if necessary. Peer reviewers and members of the SEP evaluate full proposals according to the criteria in section 7.3.2.

Full proposals are evaluated by members of the SEP and by ad hoc peer reviewers who are not members of the SEP but specialists in the area(s) concerned in the proposal. Proposals are evaluated strictly on the basis of the criteria proposed in this document. Information on the support of competitiveness clusters is taken into account by the SEP.

The list of full proposals selected by the ANR (main list and possibly reserve list) is published on the ANR website.

The ANR informs all the scientific coordinators of the result of this second stage. Grant agreements are signed between the ANR and the beneficiaries according to the rules laid down in the ANR funding regulations <http://www.agence-nationale-recherche.fr/RF>.

### 7.3.1 Eligibility criteria for full proposals

A full proposal must meet all of the following criteria:

- The proposal must be complete and in accordance with the format specified in the guide for applicants.
- The proposal must meet the specific conditions of the funding instrument chosen (see section 2).
- The content of the full proposal must comply with the pre-proposal selected in the first stage.

Administrative and financial information regarding full proposals from each partner **must be signed by the legal representative of each partner**. As soon as notice of the evaluation of the first stage has been given, applicants are therefore advised to ensure that they can obtain these signatures by the deadline for the second stage submission.

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<sup>15</sup> For young researcher projects

<sup>16</sup> For projects involving several partners

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

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

- similar<sup>17</sup> to a project already funded or being evaluated as part of a call for proposals under the ANR's programme framework
- non-unique<sup>18</sup>

### 7.3.2 Evaluation criteria for full proposals

Ad hoc peer reviewers and members of the SEP are called upon to consider the full proposals according to the four following evaluation criteria:

- Relevance of any changes to the proposal in relation to the pre-proposal (criterion for elimination if the differences are considered significant)
- Scientific excellence and/or innovative nature for technological research
- Quality of the project's construction and its feasibility
- Overall impact of the project

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<sup>17</sup> 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.

<sup>18</sup> Non-uniqueness is established when the full proposal borrows or copies, in whole or in part, earlier writings whose sources have not been quoted.