Strategy for Research, Development and Innovation

2014 - 2020

Period

innovation →

AdeME'S Strategic Guidelines
Preamble

"Carrying out the energy transition means adopting a new economic and social model, a model that revises the ways in which we work, produce, consume and live together." To build a new future, the way forward has been outlined by the National Council for the Energy Transition, by the 34 plans for the conquest of a New Industrial France, and by the proposed energy transition law in France. This legislation sets green growth objectives that presuppose sweeping changes in our technologies, economy and modes of consumption. These are not just modulations, but veritable mutations. The visions of French society in 2050 developed by ADEME show that these objectives can be obtained without reducing our well-being, and without recourse to hypothetical solutions based on techniques that are not yet mastered.

Following a trajectory to complete decarbonation of our economy by the end of the 21st century, in 2050 we will live in renovated buildings with much improved energy performance, thanks to technologies that have already been developed, and also to anticipated technical and economic progress. We will use modes of transport equipped with technological advances that are now being developed and deployed, with vehicles adapted to each kind of use. Companies will have leveraged the cleanest and most energy-efficient production technologies, facilitating recycling and the circular economy. This is not a utopian technological vision, and research and development work by French companies will make even more effective solutions available.

These changes are necessary, and the energy and environmental transition will be successful only if society evolves, without this being a burden or constraint. The countries that opt rapidly for transition will be ahead of the others in the 21st century. Public action in favour of research, technological and organisational innovation, and changes in behaviour will play a major role. ADEME's 2014-2020 research strategy pursues this dynamic movement: supporting work to meet new industrial challenges, encouraging the evolution of society, and facilitating collaboration between researchers and operators. The goal is to create the conditions for sustainable development of our society, taking into account the climatic changes to which we will have to adapt. The Investments for the Future programme piloted by ADEME since 2011 has brought forward many solutions that had been conceptualised and prepared in laboratories and companies. For ADEME the aim is to ensure a stable framework for research work that allows these innovative solutions to emerge, and to provide conditions allowing these solutions to be integrated and appropriated by actors in society via Participatory Action Research projects and pre-normative development.

At the same time, profound changes in our lifestyles are undoubtedly necessary to keep up with our desire for progress. Some of these changes are already under way, such as new mobility services and the collaborative use of consumer goods made possible by new communication technology. Others will be deployed via experiments and tests in the field. Smart technology in tomorrow's housing will allow individuals to become energy producer-consumers with the capability of making choices between their needs and the sale of their energy production. Consumers will become more attentive to health and the environment when choosing their food, opening up new opportunities for more sustainable agriculture. These transformations will be based on new economic models that allow a new form of growth and the emergence of new work practices and functions. These innovations should bring us more energy-efficient and effective technologies, and economise more resources, as our lifestyles gradually evolve, taking the wishes, uses and comfort of all into account. ADEME has been tracking these changes for several years, and will continue to include human and social sciences in its research, in order to observe, explain and accompany this evolution, because the members of society must want change in order to make it happen.
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ADEME is a core player in the implementation of national research strategies (the National Research Strategy – SNR – and the National Energy Research Strategy – SNRE); the agency takes part in research programming, and provides financial assistance for doctoral students, research projects, pre-industrial experiments and demonstrators (Investments for the Future programme).

Research action supported by the agency will focus on, among others:
• work to devise responses to the expectations of society and to provide support for public authorities to help them build sustainable development policies that match these expectations;
• ways to accompany the emergence and implementation of a national portfolio of technologies and services that meet energy and environmental challenges with a view to achieving a low-carbon society that is adapted to climate change.

More broadly, ADEME’s support for research, development and innovation (RDI) is framed in keeping with French public energy and environmental policy, and in particular policies in favour of the energy transition. The RDI directions proposed under the 2014-2020 strategy, when implemented, are expected to contribute to attaining the 2030 and 2050 visions elaborated by ADEME as part of the preparatory work for energy transition legislation. In addition, the emergence of new technologies and services developed by French companies will reinforce the positive impacts of the energy transition on growth and employment.

1. Initially entitled the National Research and Innovation Strategy (SNRI), the National Research Strategy (SNR) is now being drawn up, in keeping with the European strategy Horizon 2020. The National Research Strategy defines a limited number of areas of work that should be given priority to advance our knowledge and technologies in order to meet the scientific, technological, environmental and societal challenges that France will face in the coming decades. SNRE : Stratégie Nationale de la Recherche Énergétique.
1 - Background and stakes

1. A strong European impetus: Horizon 2020 and Structural Funds

Research and innovation are at the heart of the “Europe 2020 Strategy”, with the leading initiative called “Innovation Union” designed to stimulate competitiveness in the European Union. In this setting the European Commission proposes that steps be taken to allow the two main EU competitiveness programmes, Horizon 2020 and the Structural Funds (SF), to complement each other, and even work in synergy, for the 2014-2020 period.

a. Horizon 2020 (H2020)

Horizon 2020 constitutes the EU mechanism for funding research; it integrates and builds on the Seventh Framework Programme for Research (FP7), the innovation segment of the Competitiveness and Innovation Programme (CIP), including Smart Energy Europe and Eco-innovation, and the European Institute of Innovation & Technology (EIT). H2020 funding is aimed at large-scale investment in key industrial technologies, to optimise companies’ potential for growth and help innovative SMEs in Europe become major players in the world market. This programme targets activities related to innovation. Horizon 2020 emphasises scientific excellence, cutting-edge industrial achievements, and the quest for responses to the seven major challenges facing society today, some of which are particularly relevant to ADEME’s work:

- Health, demographic change & wellbeing
- Food security, sustainable agriculture and forestry, marine/maritime/inland water research and the bioeconomy
- Secure, clean & efficient energy
- Smart, green & integrated transport
- Climate action, environment, resource efficiency & raw materials
- Inclusive, innovative & reflective societies
- Secure societies

b. Structural Funds

The Structural Funds are designed to implement EU policies at the regional level. For 2014-2020 they are divided among 11 thematic objectives (TO), including research and innovation, the low-carbon economy, environmental protection, and sustainable transport, among others. Compared to the preceding period, a much larger share of Structural funds is expected to be allotted to research and innovation activities, benefiting growth and employment at the territorial level. This funding represents support for RDI that is significantly higher than under Horizon 2020. As part of the implementation of the research and innovation objective (Thematic Objective 1), regional authorities who manage ESF and their partners were asked to review their 2007-2013 regional innovation strategies, with a view to a smart specialisation (RIS3),

- relying on local actors in RDI in order to construct a thematic focus that matches sectoral challenges (see other TOs above, e.g. low-carbon economy, climate change, etc.) and the strengths, weaknesses, opportunities and risks in their territory,
- and to draw up their EU Structural funds operational programme, for implementation starting in 2015.

2. An evolving national situation

a. The National Research and Innovation Strategy and the National Energy Research Strategy

In energy legislation passed in 2005 France set forth the directions of its energy policy up to 2050, emphasising the central role of research and innovation (Programme d’Orientation de la Politique Énergétique, or POPE Law, 13 July 2005). The first National Energy Research Strategy, the energy segment of the National Research and Innovation Strategy, was issued in May 2007, and designated the prime themes for research in this area. In 2010 the Research Ministry and the Energy and Sustainable Development Ministry asked ADEME to work with them on updating the National Energy Research Strategy. This work drew in part on the strategic roadmaps and the notes on market opportunities in different sectors drawn up by ADEME to guide the calls for expression of interest under the Investments for the Future programme. The ministries and the working groups of the research consortium ANCRE (Alliance Nationale de Coordination de la Recherche pour l’Energie) elaborated some 15 monographs on the relevant industries and applications, reviewing the current state of work in the field, national skills and competence, bottlenecks and related R&D needs. This work was carried out in parallel with the elaboration of the strategy outlined in this document, and also nourished the Energy component of the National Research Strategy that is currently being drawn up.

b. The National Research Strategy

The document “France Europe 2020”, a strategy agenda for research, transfer and innovation, calls for setting up a National Research Strategy to replace the 2009 National Research and Innovation Strategy. This new strategy is to define the priorities for work to advance knowledge and technology. Ten principal challenges have been identified, strongly correlated to those of the European Horizon...
National Research Alliances have been charged with the mission of determining the technological or methodological turning points that should orient science policy in France, and with the task of drawing up the research programme for the National Research Agency (ANR).

c. ANR, competitiveness poles and BPI

The National Research Agency (ANR) has funded research projects since 2005, and is thus an actor in implementing the national research strategy. Projects are selected on criteria of scientific quality, ensuring that fundamental research remains at a high level while also supporting finalised and applied research. ANR was also the operator of Investments for the Future projects designed to help implement research structures, in particular the Energy Transition Institutes (Instituts de la transition énergétique, formerly IEED).

The role of the competitiveness poles is to bolster innovation by encouraging the development of collaborative and innovative research and development projects, and by accompanying work to bring to market the products, services and processes that come out of this research. The best of these R&D projects that aim at business results receive financial assistance via state aid granted by the single interministerial fund (Fonds unique interministériel, FUI) on the basis of a call for projects. The competitiveness poles are located in specific areas of the country and focus on a theme, drawing together companies, research laboratories and institutions of higher education in the territory that work in this area. Certain competitiveness poles target domains in which ADEME is active.

The public institution Banque Publique d’Investissement (Bpifrance) provides financial support for small and intermediate-sized enterprises and accompanies their innovation projects, from aid for R&D activity, to loans from its own funds for industrial development in innovative companies. Some of these programmes may target energy and environment themes.

d. A stronger role for regional governments

Recent legislation on higher education and research in France (Law no. 2013-60, 22 July 2031)

• strengthens the role of regional governments in defining research policy, and provides funding. The regions have thus taken on a coordinating role for territorial initiatives aimed at developing and disseminating research.

Themes of roadmaps realized by ADEME by main programme

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<tr>
<th>Sustainable production and renewable energy</th>
<th>Sustainable cities, towns and territories</th>
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<td>• Renewable Marine energy</td>
<td>• Smart electricity systems</td>
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<td>• Photovoltaic electricity</td>
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<td>• Hydrogen energy and fuel cells</td>
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<td>• Energy storage systems</td>
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<td>• Geothermal energy</td>
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<td>• Rail Systems</td>
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<td>• Eco-designed products, processes and services</td>
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<tr>
<td>• Solar Thermal Energy</td>
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<td>• Capture, transport, geological storage and re-use of CO₂</td>
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<td>• Waste collection, sorting, recycling and recovery</td>
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<th>Agriculture, forests, soils and biomass</th>
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<td>• Advanced biofuels</td>
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<td>• R&amp;D in plant chemistry</td>
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<td>• Integrated management of soils, ground water and sediment</td>
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2. The brief of the National Research Alliances is to strengthen the coordination of research work and to bring together the various public actors in research. There are now five such alliances in France, covering life science and health, energy, information science and technology, the environment, and human and social sciences.
mining scientific, technical and industrial culture, other than nationally piloted missions, and within the framework of the national research strategy;

- to fulfil this role the regions are charged with coordinating education and training opportunities, and the research and transfer strategies of higher education institutions, and their work with associated research bodies. The regional governments are to set up new forms of cooperation, notably communities of universities and other establishments, which are destined to replace the research and higher education poles (Pôles de recherche et d’enseignement supérieur, PRES).

3. ADEME in the French RDI system

Listed as a thematic agency under the national research strategy, ADEME tailors its RDI support to complement that of other funders of research. ADEME is present at all stages of scientific research and of the innovation process, through three complementary instruments: the doctoral theses programme, RDI budgets, and the Investments for the Future programme (Programme d’Investissements d’Avenir, PIA). The specific nature of ADEME’s intervention lies in the finalised and near-market outcomes of the research work the agency supports, in particular via the Investments for the Future. By elaborating strategic roadmaps for the different areas of competence covered by ADEME, the agency helps define orientations for calls for expression of interest under the Investments for the Future programme, and R&D priorities. On the basis of this work ADEME has drawn up visions for 2030 and 2050 that were used in the National Debate on the Energy Transition. Based on this knowledge of markets, relayed in notes on opportunities drawn up to prepare calls for expression of interest under the Investments for the Future programme, ADEME has outlined RDI strategies for certain high-priority industries and activities in the framework of the National Energy Research Strategy (see I.2.b).

ADEME, administrator of Investments for the Future, is the main operator for new energy and environmental technologies, with a programme budget of 2.3 billion for the initial period 2010-2015, devoted to low-carbon energy and green chemicals, smart grids, the circular economy, and future vehicles. Because Investments for the Future focuses on near-market innovation, ADEME’s R&D activity is positioned upstream of this programme, but is articulated with feedback from projects supported by Investments for the Future that would benefit from research work to eliminate certain bottlenecks.

ADEME fosters collaboration between companies and public research laboratories, with 80% of research budgets (not including Investments for the Future) devoted to industrial research and experimental development during the 2007-2011 period, and over 60% channelled to companies. ADEME works with competitiveness poles that target the agency’s areas of action, and provides guidance through its strategic research roadmaps.
Following up on its 2007-2010 research strategy, ADEME conducted an assessment of this strategy, and undertook to revise it in keeping with the European and national guidelines and stakes described above. The new RDI strategy is framed for 2014-2020, matching the period of the European research programme. This strategy states the aims of ADEME’s R&D activity, and is intended to set priorities and to guide the implementation of research programmes and doctoral thesis support, according to their specific subjects. The strategy also provides guidance for the programming of calls for expression of interest under the Investments for the Future programme, proposing priorities to the programme’s governing body. At the same time ADEME accompanies innovation through other activities (in particular the “innovative companies” scheme focusing on business strategies) and takes care to ensure that their options are consistent and in synergy with the priorities given in the present strategy.

**Overall objective:** to encourage research to accompany the energy and environmental transition and the fight to mitigate climate change, with a view to paving the way and providing support for operational activities led by ADEME.

Focusing on achieving the objectives set by the ministries that oversee the agency, ADEME articulates its research orientation and coordination missions, that constitute the implementation of the research facets of the policies entrusted to ADEME, with the agency’s other types of action: decision-making aids, support for exemplary operations and dissemination projects, information and awareness action, data collection, etc.

The overall strategic objective cited above is firstly to anchor ADEME’s research projects and programmes in real-life operations, and to have access to feedback on dissemination of technologies, conditions for bringing them to market, identification of bottlenecks, etc., and, in addition, to base the agency’s operational action on up-to-date scientific knowledge. This overall objective spans four specific objectives described in detail below.

**Specific objective no. 1: Foster the emergence of new solutions/services, energy and environmental technologies, and options to combat climate change**

In keeping with the highly operational focus of its missions, ADEME’s RDI activity is informed by the logic of industry, with a growing trend towards industrialisation aimed at bringing technologies to market, supporting the energy transition (energy efficiency, renewable energies), environmental concerns (waste, air quality, soils, noise) and the fight against climate change. By laying the groundwork for industrial exploitation, the projects funded by ADEME under the Investments...
for the Future programme have massively contributed to obtaining value from the results of research work carried out in recent years. Now the actors in public and private-sector research must be mobilised and directed to new concepts, in particular those highlighted by the initial results of the projects supported by the Demonstrators Fund and the Investments for the Future, to maintain the dynamic progression created by these programmes. Certain industries and activities now emerge as high priorities, in light of the stakes, and public and industrial competencies in France, but these activities are not yet sufficiently mature to pilot large near-industrial projects of the type supported by Investments for the Future. It is time to break scientific and technological bottlenecks in order to move on to the demonstrators phase. In addition, development support for innovative ecotechnologies will have to prepare and anticipate the Environmental Technology Verification (ETV) process to validate performance when the technologies are brought to market.

Specific objective no. 2: Produce contextual knowledge that is relevant and directly usable by actors in the economy and in society, by accompanying Participatory Action Research projects

Specific objective no. 1 above will for the most part support research and innovation to improve the technical and functional performance of technical objects (buildings, vehicles, grids, etc.) and/or areas of activity (energy, waste management, etc.). Beyond work on scientific and technological bottlenecks, ADEME research programmes will also aim to ensure transfer of results to final users and to address the needs of society. ADEME will look to support Participatory Action Research projects based on organisational experiments, the aim being to accompany experimentation related to the energy and environment transition, and to the fight against climate change conducted by local actors, along the lines of projects focusing on sustainable urban mobility, smart electricity grids, positive-energy buildings, among others, that receive support under the Investments for the Future programme. Other ADEME research projects will yield operational results such as methodological guidelines and decision-making aids that can be appropriated by actors in society. With the objective of producing scientific knowledge in context so it can be used by actors in society and the economy, a cross-disciplinary approach must now be promoted in certain areas, with field work to back up research. To achieve this ADEME’s regional offices facilitate the setting up of field experiments.

Specific objective no. 3: Accompany research that prefigures action on standards, regulations, labels and certification

Pre-normative research is a key stage in bringing commercially competitive innovations to market. ADEME can accompany work to develop standards in its areas of action and can fund the necessary pre-normative research (for example, elaboration of a protocol and validation in inter-laboratory testing). Work to support development of regulations, labels and certification is also one of the agency’s missions. Before enacting a decision, via regulatory mechanisms, the different options available must be analysed on the basis of detailed knowledge and evaluation of the associated risks. Labels and certification are important information tools that constitute a quality guarantee for the products and services proposed, necessitating criteria for qualification. Preliminary research may be needed to better qualify the scientific and technical bases for elaboration of these tools.

Specific objective no. 4: Strengthen the coordination of EU, national and regional research work

At the European level, ADEME is a stakeholder in many action programmes – Structural funds, contribution to transnational programming under ERA-NET, national promotion of EU Research framework programme, national promotion of EU Research framework programme. The agency works to ensure that the various national programmes and initiatives under its guidance are consistent and compliant with EU tools aimed at financing research and innovation. ADEME helps project owners gain access to these tools, thanks in particular to its role as coordinator of national energy and environment contact points. The priority themes of ADEME’s Research Strategy have been elaborated to be consistent with the orientations of Horizon 2020 and France–Europe 2020 strategy. These new strategic research directions also constitute a frame of reference for ADEME’s regional offices in the elaboration and orientation of the “research and innovation” themes of structural funds operational programmes (OP).
1. Main programmes and specific programmes in ADEME’s Research Strategy

Upstream of the Investments for the Future Programme, ADEME’s research strategy is divided into five main programmes, further subdivided into 13 specific programmes, each of which integrates its own vision.

European and international commitments related to climate change (greenhouse gases, renewable energies, energy efficiency, among others) have established a relatively consensual agenda:
- greenhouse gas emissions to be cut by 75% by 2050;
- reduction, as broad as possible, of dependence on carbon fuels, and a greater share of renewable energy resources in the energy mix;
- sufficient capacity to adapt to climate change;
- greater attention to social inequalities, in terms of energy, health, environment and territories.

Despite these commitments that have progressively put into action, climate change continues, and starting now adaptation strategies that are consistent with mitigation policies must be planned. The aim is to move towards climate policies under which mitigation and adaptation are addressed together, seeking all possible synergy, including with other environmental policies. To foster synergy effects, ADEME calls for climate change research to be integrated into these specific programmes.

The expected outcomes are:
- better knowledge of the consequences of climate change on the industrial activity and sectors in which ADEME has a role, in order to provide technological and organisational responses, the knowledge gained by this research will enrich the decision-making tools proposed by ADEME,
- ways to bring about changes in behaviours, practices and lifestyles, and to mobilise actors in the field in support of long-term climate policies (regulation, governance, communication),
- identification of new instruments and forms of public and private-sector financing that can be leveraged to encourage synergistic action.

Research to develop climate models or to furnish climate data does not come under ADEME’s brief. Nonetheless, ADEME’s research activity may help better define users’ data needs.

The "Sustainable cities, towns and territories" programme aims to cut greenhouse gas emissions by 75% by 2050, by developing solutions and technologies that minimise the energy and environmental impacts of cities, towns and territories. This objective focuses in particular on urban areas, with twin

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<td>Transport and mobility: from clean and energyefficient vehicles to complex mobility systems</td>
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<tr>
<td>Sustainable production and renewable energy</td>
<td>Ecodesign and ecoefficiency for production systems</td>
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<td>Capturing and using CO2</td>
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<td>Waste and materials: waste collection, sorting, recycling and recovery of valuable materials</td>
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<tr>
<td>Agriculture, forests, soils and biomass</td>
<td>Sustainable production of raw materials in agriculture and forestry</td>
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<td>Characterisation of biomass, exploitation and materials recovery</td>
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<td>Sustainable management of soils and subsoil zones, polluted site cleanup, rehabilitation of degraded lands and property, underground CO2 storage</td>
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<td>Air quality, health and environmental</td>
<td>Protection and improvement of air quality</td>
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<td>Evaluation of environmental and health impacts, decision-making aids</td>
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<td>Energy, environment and society</td>
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constraints: tomorrow’s cities have for the most part already been built, given the low rate of renewal of building stock and infrastructure for energy, transport, leisure activities, etc., and in this time frame the effects of climate change will be even more marked. The object is to participate in the adaptation and the organization of tomorrow’s cities, coordinating a grid of several territorial scales: islands – the neighborhood space; urban areas – the space of daily interaction that reflects infrastructure decisions (energy, transport, etc.); and metropolitan areas – the space of exchange and flows of goods, services, people, and the interconnection of networks.

Three major vectors are key to this systemic vision:
• the built environment, from buildings to urban and spatial planning
• transport and mobility, considering advances in vehicle technology and evolving infrastructure
• regional and decentralized energy system.

On a society-wide scale, consumption leads to significant CO₂ emissions and/or waste generation. The "Sustainable production and renewable energy" programme focuses on improving the environmental efficiency of production systems, including renewable energy production and efficient use of resources. This programme addresses the following topics:
• making production systems more efficient (gains in productivity, reduced environmental impact), less dependent on energy and natural resources, and less vulnerable to fluctuation of prices on highly competitive markets;
• encouraging commercial offers of goods and services that are eodesigned following a multi-criteria process – covering resource consumption, air, water and soil pollution, waste generation, etc. – applied to the entire product life cycle;
• fostering the design and development of innovative energy systems that will hold up under climate change;
• promoting the transition to a circular economy, by positioning waste management industries and activities as a link firmly integrated into materials life cycles, and by promoting the substitution of primary resources by secondary resources thereby improving the environmental footprint of products.

The broad programme "Agriculture, forests, soils and biomass" is intended to support sustainable management of soil and subsoil zones, agriculture and sylviculture, and to enhance the recovery of biomass resources. Today the main challenge for the production of primary agricultural and forestry materials is to produce more and in better ways, protecting air, water and soil quality, so as to preserve a renewable natural resource. In light of the pressure on biomass resources, that are increasingly sought after for new uses, as an energy resource in particular, it is necessary to use available biomass more efficiently by optimising cultivation and processing. In this context soil, the nourishing substrate, is a vital element for biomass production. Degradation of soil can be catastrophic and in some cases irreversible. Particular care must be taken to maintain soil quality, and to develop ways to better characterise pollution and improve existing treatment options.

The "Air quality, health and environmental impacts" programme aims to accompany and evaluate implementation of concrete and effective action to protect and improve air quality, to improve multicriteria evaluation methods and decision-making tools designed to limit the impact
of human activities and technologies on health and the environment, and to gain better knowledge of multiple-exposure issues and emerging pollutants. Research will focus on the following:

• development, optimisation and evaluation of new solutions to improve indoor and exterior air quality, in the various fields in which ADEME is active;
• development of data, methods and tools to better qualify the impact of action and technologies supported by the agency;
• characterisation of multiple-exposure situations and their impacts on health and the environment, and the associated risks.

How can we organise an environmental transition towards an economy that uses less energy and fewer resources, creates less pollution, emits fewer greenhouse gases and is adapted to climate change? Reducing our energy consumption and moving towards sustainable consumption would help, but technical progress alone will not suffice to attain these environmental objectives. Human and social sciences enable us to observe and understand the ways in which societies produce, consume, build, and more generally grow and develop. They have an important role to play in informing and supporting public policies.

The "Energy, environment and society" programme aims to:

• pinpoint bottlenecks that block change and the dissemination of new technologies,
• identify and analyse social innovations, "new" forms of social and economic organisation, to gain understanding of the conditions that allow them to emerge, and eventually foster them.

To achieve the overall objective of the research strategy, i.e. "To encourage research to accompany the energy and environmental transition and the fight to mitigate climate change with a view to paving the way and providing support for operational activities led by ADEME", the agency has concentrated its efforts on three of the main programmes: "Sustainable cities, towns and territories", Sustainable production and renewable energy", and "Agriculture, forests, soils and biomass". The other two main programmes, "Air quality, health and environmental impacts" and "Energy, environment and society" are nonetheless an essential base for the implementation of the agency’s missions, for they are designed to:

• acquire the knowledge needed to qualify the impacts of solutions and technologies,
• develop approaches and methodologies that can subsequently be applied in the three other programmes,
• determine the opportunity, feasibility and conditions of implementation for the proposed innovations.
Examples of results obtained through research supported by ADEME

**Sustainable cities, towns and territories**

Research in the buildings sector is supported by ADEME mainly via two mechanisms. The first is the national research programme Programme de Recherche et d’Expérimentation sur l’Énergie dans le BATiment (PREBAT) that brings together work conducted by the National Research Agency, the Plan Urbanisme Construction Architecture (PUCA) and the Agence Nationale de l’Habitat (ANAH). The second mechanism is based on calls for projects – Programmes d’Actions Concertées en Technologies de l’Énergie (PACTEs) – a programme created by ADEME to resolve technological bottlenecks that have been identified as impeding progress to achieve the goals set by the Grenelle conference. The PACTEs mechanism has spurred the creation of consortia with multiple competences to focus on developing solutions that can be effectively integrated into structures. In this context ADEME has supported research on super-insulating materials, and air-conditioning and ventilation equipment, among others. The ALDES multifunction ventilation system (ventilation, heating and cooling) has been brought to market, under the name TZen.

**Sustainable production and renewable energy**

At present wind power installations generating a little over 3,000 MW are affected by regulations establishing easements to protect radar equipment, for the most part weather stations and military radar posts. While studies have been carried out, in the United Kingdom and in Germany in particular, for the time being no turbine blade with a low radar signature is available on the market. The partners in the EODIS project, ASTRIUM, ONERA and PLASTINOV, undertook to devise and validate various ways to attenuate radar disturbance, principally by acting on wind turbine blade design. A technology with significant radar absorption levels, meeting the radar signature minimisation goals, has been developed and confirmed in testing, and can be integrated into a turbine blade.

**Waste and materials**

The REPAR project espouses the reuse of building materials, as a bridge between architecture and industry. The project was initiated by the architects’ group Bellastock; with the mixed-economy corporation Plaine Commune they have successfully established the practice of reusing construction materials in situ, at an industrial brownfields site being converted to an eco-neighbourhood. Materials streams are minimised and stock management optimised, in a three-stage process: diagnostic, preparation for reuse, reuse. Habitual deconstruction practices have been...
slightly modified, and adapted to the type of material (concrete, metal, etc.), using whenever possible equipment and resources at the site, cost reduction practices, and taking advantage of long worksite time frames. The added cost of selective deconstruction, due to removing and setting aside materials before demolition, is compensated by lower costs for waste removal (less waste is generated) and for bringing new materials to the site.

**Agriculture, forests, soils and biomass**

A country-wide map showing the location of carbon stored as organic matter in soils has been established using data from GIS Sol; the national stock of carbon is estimated at over 3 billion tonnes. Sampling and simulation campaigns are underway to assess the degree to which these carbon stocks are vulnerable to climate change, and to various uses and practices. Under the CITYCHLOR project, cofunded by the European INTERREG IV programme, an integrated risk management approach has been developed to handle solvents in urban areas, facilitating reconversion of urban brownfields. This approach is based on technical methods to characterise pollution and remediation solutions, risk assessment methodologies, and involvement of residents. Urban planning and development considerations are taken into account, as well as related legal and socioeconomic issues. This project has produced a methodology, focusing on key factors for success, which offers a broad approach to regrouping sites in an urban area, rather than the traditional site-by-site case study.

**Energy, environment and society**

In addition to their remarkable environmental performance (very effective building envelope, airtightness, highly efficient heating, improved ventilation, triple glazing, renewable energies), the 2,950 exemplary low-energy buildings constructed under the auspices of PREBAT also provide an opportunity to look at the behaviour of occupants and managers. Initial feedback on these energy efficient buildings reveals a gap between expected energy consumption and actual data. One of the prime reasons for this gap is the in vitro conception of the energy performance scheme. Occupants (residents and employees) and professionals (designers, managers, operators) have been surveyed in field research to explain the observed discrepancy. This research shows how technical and human factors are intertwined in the operating costs and energy performance of buildings, as a multitude of actors are driven by different rationales.
2. Implementation measures

In addition to stimulating and guiding research work, ADEME provides financial assistance for RDI under its doctoral theses programme, and via competitive calls for proposals and calls for expression of interest under the Investments for the Future programme.

RDI directions that have been designated as high-priority in calls for expression of interest under the Investments for the Future programme will receive financial aid under the programme’s rules. This comprises state aid in the form of repayable advances, grants, and participation as an informed investor.

ADEME’s calls for research projects solicit mainly collaborative projects that involve at least one company, especially when the expected outcomes are solutions that can be industrially produced for the commercial market. At the same time, ADEME may directly fund research projects under one-to-one agreements, when justified. These projects are for the most part proposed by companies that seek to resolve specific bottlenecks in a short time.

The funding provided by ADEME under its R&D budget is mainly in the form of grants. In some instances however, given that some research funded by ADEME aims to achieve high levels of maturity, financial aid may take the form of repayable advances. The decision to allocate a grant or a repayable advance depends on the nature of the research being funded, and the existence of potential markets in relation to the research.

ADEME’s doctoral theses programme finances research of a more prospective nature, to explore new topics or investigate a given subject in greater depth. Doctoral candidates are employed by ADEME and assigned to a research laboratory. They thus benefit from the oversight of a thesis director, and that of an expert at ADEME, for the duration of their thesis work. Under this programme ADEME is able to:

- involve doctoral researchers in specific events, seminars, meetings with the agency’s partners, and gradually introduce them into the professional sphere,
- integrate research results very early on into the agency’s operational action, and thus maintain a high level of expertise.

Thesis research is for the most part cofinanced by a company or a local authority, ensuring that actors in society and in the economy have a stake in the research work.

In the framework of the objective "Strengthen the coordination of EU, national and regional research work" ADEME will pay close attention to:

- setting up and participating in ERA-NETs in the agency’s areas of activity, in order to:
  - elicit transnational calls for projects on the agency’s themes when collaboration with other countries can be useful for the development of a given technology, energy or environmental solution,
  - create a leverage effect via an EU contribution, to finance coordination;
- seek synergy between funding of RDI by ADEME, regional and EU structural funds, in ways that remain to be agreed between the partners.

ADEME will also work in collaboration with other funding entities (ANR, FUI, regional governments, Bpifrance) and the Investments for the Future programme, and seek partnerships to accompany research.

3. Specific programmes and types of research targeted

The 13 specific programmes are described in detail in separate documents outlining for each programme the research topics to be pursued and the type of research that is desired.

The table below specifies the type of research sought by ADEME, using the TRL scale to assess maturity.

### Support of the RDI by ADEME

<table>
<thead>
<tr>
<th>Specific programme</th>
<th>Doctoral thesis with ADEME</th>
<th>Research and development programme</th>
<th>Investments for the Future programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of funding</td>
<td>Thesis stipend</td>
<td>Mostly grants, and repayable aid</td>
<td>Repayable aid and grants Capital investment</td>
</tr>
<tr>
<td>Beneficiaries</td>
<td>Doctoral candidates (3-year employment contract with ADEME)</td>
<td>Research bodies Companies Non-profits and local authorities</td>
<td>Mostly companies</td>
</tr>
<tr>
<td>Type of project funded</td>
<td>Concept–Feasibility</td>
<td>Development–Experimental implementation–Participatory Action Research–Prenormative research</td>
<td>Demonstration Scale 1 experimentation Initial industrial scaleup</td>
</tr>
<tr>
<td>Project maturity/TRL</td>
<td>TRL 3 to 4</td>
<td>TRL 4 to 7</td>
<td>TRL 6 to 9</td>
</tr>
</tbody>
</table>

3. The Technology Readiness Level (TRL) refers to a scale devised to assess the maturity of a technology. Initially used by the US Department of Energy, this scale defines nine levels to position a technology in the process leading to development. Using this scale the progression of a given project or research topic can be tracked, from basic research to commercial market.
<table>
<thead>
<tr>
<th>TRL Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRL 0: Idea</td>
<td>Unproven idea or concept where no peer reviewed analysis or testing has been performed.</td>
</tr>
<tr>
<td>TRL 1: Basic Research</td>
<td>The initial scientific research has been completed. The basic principles of the idea have been qualitatively postulated and observed. The process outlines have been identified. No experimental proof and detailed analysis are yet available.</td>
</tr>
<tr>
<td>TRL 2: Technology formulation</td>
<td>The technology concept, its application and its implementation have been formulated. The development roadmap is outlined. Studies and small experiments provide a “proof of concept” for the technology concepts.</td>
</tr>
<tr>
<td>TRL 3: Applied Research</td>
<td>The first laboratory experiments have been completed. The concept and the processes have been proven at laboratory scale, tabletop experiments. Potential of materials and up-scaling issues have been identified.</td>
</tr>
<tr>
<td>TRL 4: Small Scale Prototype Development Unit (PDU)</td>
<td>The components of the technology have been identified. A PDU has been built in a laboratory and controlled environment. Operations have provided data to identify potential up-scaling and operational issues. Measurements validate analytical predictions of the separate elements of the technology. Simulation of the processes has been validated. Preliminary LCA and economy assessment models have been developed.</td>
</tr>
<tr>
<td>TRL 5: Large Scale Prototype Development Unit</td>
<td>The technology has been qualified through testing in intended environment, simulated or actual. The new hardware is ready for first use. Process modeling (technical and economic) is refined. LCA and economy assessment models have been validated. Where it is relevant for further up-scaling the following issues have been identified: Health &amp; safety, environmental constraints, regulations, and resource availability.</td>
</tr>
<tr>
<td>TRL 6: Prototype System</td>
<td>The components and the processes have been up-scaled to prove the industrial potential and its integration within the energy system. Hardware has been modified and up-scaled. Most of the issues identified earlier have been resolved. Full commercial scale system has been identified and modeled. LCA and economic assessments have been refined.</td>
</tr>
<tr>
<td>TRL 7: Demonstration System</td>
<td>The technology has been proven to work and operate at pre-commercial scale. Final operational and manufacturing issues have been identified. Minor technology issues have been solved. LCA and economic assessments have been refined.</td>
</tr>
<tr>
<td>TRL 8: First of the kind commercial System</td>
<td>The technology has been proven to work at a commercial level through a full-scale application. All operational and manufacturing issues have been solved.</td>
</tr>
<tr>
<td>TRL 9: Full commercial application</td>
<td>The technology has been fully developed and is commercially available for any consumers.</td>
</tr>
</tbody>
</table>
The built environment: sustainable territories with high-performance buildings

Theme 1: Low-carbon construction techniques for advanced clean and healthy buildings
1.1. Construction materials, equipment and systems
1.2. Low-carbon construction

Theme 2: An efficient built environment for and in its surroundings
2.1. Anticipate health and environmental impacts of advanced buildings in a changing climate
2.2. Accompany the overall evolution of building stock
2.3. Bolster performance at building, island and neighbourhood level

Theme 3: High energy-efficiency and climate-ready urban systems with low environmental and health impacts
3.1. Understanding the organisation and dynamics of urban systems
3.2. Conceptualise urban systems for high energy, climate, environmental and health performance
3.3. Commit urban systems and territories to a low-carbon path

Development from TRL 4 to TRL 7

Experimental implementation of methodologies and technologies at TRL 6 and TRL 7

Transport and mobility: From clean and energy-efficient vehicles to complex mobility systems

Theme 1: Clean and energy-efficient vehicles
1.1. Engine-drive units and auxiliary equipment
1.2. Vehicles and modes of transport

Theme 2: Optimisation of vehicle – infrastructure interaction
2.1. Electric-powered mobility
2.2. Information management systems for smart vehicles and infrastructure

Theme 3: Complex transport systems
3.1. Spatial dynamics and mobility
3.2. Innovative mobility and freight systems
3.3. Transport integration, interoperability and intermodality
3.4. Governance and acceptance

Characterisation of technological objects at TRL 9

Experimental implementation of technological objects at TRL 5 to TRL 7

TRL 4 to TRL 7
TRL 6 to TRL 7 and prenormative research
<table>
<thead>
<tr>
<th>Main programme</th>
<th>Specific programme</th>
<th>Research themes</th>
<th>Type of research sought by ADEME – TRL for technological research</th>
</tr>
</thead>
</table>
| SUSTAINABLE CITIES, TOWNS AND TERRITORIES | Smart energy systems and their environments | Theme 1: Resources, planning and impacts of energy systems  
1.1. Supplies and reserves / Production / Demand  
1.2. Architecture, planning and sizing of energy grids and systems (including interaction between networks)  
1.3. Knowledge and management of environmental and societal impacts | TRL 4 to TRL 6 |
| | | Theme 2: Exploitation of energy systems / Energy demand management operations / Interaction with mobility, built environment, industrial and tertiary sector activity  
2.1. Exploitation of energy systems  
2.2. Interaction between energy grids / built environment / mobility / industrial and tertiary sector activity  
2.3. Energy demand management | TRL 5 to TRL 7 |
| | | Theme 3: Technic and economic tools, business models, energy markets  
3.1. Technical and economic tools  
3.2. Energy markets  
3.3. Tariffs and business models | |
| SUSTAINABLE PRODUCTION AND RENEWABLE ENERGY | Ecodesign and ecoefficiency for production systems | Theme 1: Encourage ecodesign approaches for products, goods and services  
1.1. Technological research related to product ecodesign  
1.2. Methodological research related to product ecodesign | Breakthrough projects or incremental innovation – TRL 4 to TRL 6 |
| | | Theme 2: Reduce resource consumption and impacts of production systems  
2.1. Lower the cost of advanced equipment in order to boost dissemination  
2.2. Development of analytical methodologies on process or production-line scale in order to identify new configurations or better technological components  
2.3. Performance during nonstandard operations in production systems (standby mode, under capacity, intermittent or flexible operation, etc.) | Experimental implementation of tools, methods and prototypes – TRL 6 to TRL 7 |
| | | Theme 3: Industrial symbiosis | Participatory Action Research |

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<tbody>
<tr>
<td>Energy vectors from renewable resources: production, management and storage</td>
<td>Theme 1: Energy production technologies</td>
<td>TRL 4 to TRL 7 and prenormative research</td>
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<td>Theme 2: Energy management technologies (grid equipment, information and telecommunications technologies)</td>
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<td>Theme 3: Energy conversion and storage solutions</td>
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<tr>
<td>CO₂ capture and re-use</td>
<td>Theme 1: CO₂ capture</td>
<td>TRL 4 to TRL 7</td>
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<td></td>
<td>Theme 2: Development of new addedvalue uses for CO₂ recovered from industrial processes, energy generation and gas purification</td>
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<td>2.1. CO₂ recovery by chemical transformation</td>
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<td></td>
<td>2.2. CO₂ recovery by biological transformation</td>
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<td></td>
<td>2.3. Social feasibility</td>
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<tr>
<td>Waste and materials: waste collection, sorting, recycling and recovery of valuable materials</td>
<td>Theme 1: Develop knowledge relating to waste management systems and recycled primary materials</td>
<td>TRL 4 to TRL 7</td>
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<td></td>
<td>1.1. Develop knowledge relating to supplies and characteristics of waste and secondary resources</td>
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<td>1.2. Develop knowledge relating to primary resources markets and public policies</td>
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<td>Theme 2: Technological and organisational innovations in waste management</td>
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<td></td>
<td>2.1. Collection</td>
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<td>2.2. Sorting and processing of used materials and products</td>
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<td>2.3. Transformation and processing of resources</td>
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<td>2.4. Methanisation and thermal treatment of waste</td>
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<td>Theme 3: Assess environmental and health impacts of waste management and production of secondary resources</td>
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<td></td>
<td>3.1. Environmental impacts</td>
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<td>3.2. Health impacts</td>
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</table>
| **Sustainable production of raw materials in agriculture and forestry** | **Theme 1:** Energy, environmental and climate performance of agricultural and forestry systems  
1.1. Environmental assessment and optimisation of agricultural and forestry systems  
1.2. Resilience of agricultural and forestry systems under climate change – Optimisation of agricultural and forestry systems  
**Theme 2:** Impediments and levers for change in agricultural and forestry systems | TRL 4 to TRL 7  
Participatory Action Research on tools and methods |
| **Characterisation of biomass, exploitation and materials recovery** | **Theme 1:** Acquisition and processing of biomass  
1.1. Assessment of available supply and characterisation of different forms of biomass  
1.2. Optimisation biomass acquisition  
1.3. Optimisation of biomass pretreatment and preprocessing  
**Theme 2:** Bioresources for chemicals, materials and energy  
2.1. Optimisation of biorefineries processing several biomass resources into different products for chemicals and energy  
2.2. Multicriteria assessment of environmental impacts related to development of biosourced products | TRL 4 to TRL 7  
Pre-normative research on biosourced products  
Participatory Action Research to accompany changes in behaviour |
| **Sustainable management of soils and subsoil zones, polluted site cleanup, rehabilitation of degraded lands and property, underground CO₂ storage** | **Theme 1:** Soil quality, uses and services  
1.1. Understanding of soil functioning and services rendered  
1.2. Observation of soil quality and assessment of impacts of climate change  
1.3. Analysis of impacts of changes in soil use  
1.4. Social, economic and political issues  
**Theme 2:** Rehabilitation of polluted sites and re-appropriation of degraded properties  
2.1. Characterisation of soil and groundwater pollution, and their health and environmental impacts  
2.2. Development of soil and groundwater treatment technologies and assessment of their performance  
2.3. Development and assessment of reconstruction methods for soils and management of degraded spaces  
2.4. Facilitation of property redevelopment in urban strategies  
**Theme 3:** Geological storage of CO₂  
3.1. Characterisation and management of CO₂ storage sites  
3.2. Conflicts between uses of subsurface zones, social feasibility, economic and regulatory issues | TRL 4 to TRL 7  
Participatory Action Research |
<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>Protection and improvement of air quality</td>
<td>Theme 1: Acquisition of effective solutions to improve indoor and outdoor air quality 1.1. Foster cross-cutting and integrated approaches 1.2. Support the development of solutions to improve air quality</td>
<td>Theme 2: Improve analysis of air pollution and its effects 2.1. Characterisation of outdoor air pollution 2.2. Characterisation of indoor air pollution 2.3. Gain better knowledge of the impact of pollutants</td>
<td>TRL 4 to TRL 7 Pre-normative research Participatory Action Research</td>
</tr>
<tr>
<td>Evaluation of environmental and health impacts, decision-making aids</td>
<td>Theme 1: Inventory data, health and environmental impact indicators, life cycle analyses 1.1. Life cycle analysis inventory data 1.2. Health and environmental impact indicators 1.3. Life cycle analyses</td>
<td>Theme 2: Methodological improvements for health risk assessment 2.1. Characterisation of multiple exposure situations 2.2. Improved assessment of health risks</td>
<td>Research related to methodology Participatory Action Research</td>
</tr>
<tr>
<td>ENERGY ENVIRONMENT AND SOCIETY</td>
<td>Theme 1: Households and environmental stakes: levers and weak signals 1.1. Practices and lifestyles 1.2. Social innovations</td>
<td>Theme 2: Environmental transition of territories and economic activities 2.1. New forms of organisation and the economy 2.2. Governance of the energy transition</td>
<td>New knowledge Participatory Action Research</td>
</tr>
<tr>
<td></td>
<td>Theme 3: Prospective studies and new instruments 3.1. Public policy instruments 3.2. Forward-looking scenarios</td>
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</table>

French Environment & Energy Management Agency (ADEME)
ABOUT ADEME

The French Environment and Energy Management Agency (ADEME) is active in the implementation of public policy in the areas of the environment, energy and sustainable development. The Agency provides expertise and advisory services to businesses, local authorities and communities, government bodies and the public at large, to enable them to establish and consolidate their environmental action. As part of this work, ADEME helps finance projects, from research to implementation, in the areas of waste management, soil conservation, energy efficiency and renewable energy, air quality and noise abatement.

ADEME is a public agency under the joint authority of the Ministry for Ecology, Sustainable Development and Energy, and the Ministry for primary, secondary and Higher Education and Research.

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