



Activity Report

2015-2016



French National Alliance for Energy Research Coordination

Created on 17 July 2009, ANCRE (French National Alliance for Energy Research Coordination) brings together 19 research and innovation bodies and higher education institution consortia in the field of energy.

Its missions, carried out in liaison with competitiveness clusters and funding agencies, are to:

- reinforce synergies and partnerships between research bodies, universities and companies,
- identify scientific and technical challenges hampering industrial development,
- propose research and innovation programs and approaches to their implementation,
- contribute to the development of national research strategy in the field of energy, as well as funding agency program development.

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Chairman of ANCRE**

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Founding members

CEA: French Alternative Energies and Atomic Energy Commission

CNRS: French National Center for Scientific Research

CPU: French Conference of University Presidents

IFPEN: IFP Energies nouvelles

Associate members

ANDRA: French National Radioactive Waste Management Agency

BRGM: French National Geological Survey

CDEFI: French Conference of Deans of French Schools of Engineering

CIRAD: French Agricultural Research Centre for International Development

CSTB: French Scientific and Technical Center for the Construction Industry

IFREMER: French Research Institute for Exploitation of the Sea

IFSTTAR: French Institute of Sciences and Technology for Transport,
Development and Networks

INERIS: French National Institute for Industrial Environment and Risks

INRA: French National Institute for Agricultural Research

INRIA: French National Institute for Research in Computer Science and Control

IRD: French National Research Institute for Sustainable Development

IRSN: French Institute for Radiation Protection and Nuclear Safety

IRSTEA: French National Research Institute of Science and Technology
for Environment and Agriculture

LNE: French National Laboratory for Metrology and Tests

ONERA: French National Aerospace Research Center



EDITORIAL

Didier Houssin

Chairman of ANCRE

The years 2015-2016 were an eventful period for the energy sector: success of the 21st Conference of Parties on climate change (COP21), European Council approval of the 2030 Energy-Climate package, enactment of legislation relating to the energy transition for green growth, launch of the French National Energy Research Strategy.

All these events provided ANCRE with numerous opportunities to present its work and its proposals. As part of COP21, for example, ANCRE organized two conferences on the role of hydrogen in the energy transition and the Decarbonization Wedges study, which makes recommendations for speeding up the roll-out of low-carbon technologies worldwide.

One of ANCRE's main strengths is its capacity to identify future challenges and carry out technical and economic forecasting studies, which can subsequently be used as a basis for the drawing up of strategic priorities and research and innovation roadmaps. Since 2013, ANCRE has thus developed several contrasting scenarios for the evolution of the French energy system up to 2050, helping to feed the National Debate on the Energy Transition known as the DNTE, as well as its own proposals in the context of the development of national research strategy (SNR, which stands for National Strategy for Research). These scenarios are currently being updated to take into account the quantitative targets set out in energy transition for green growth legislation with a view to contributing to long-term energy program activities.

Another example of ANCRE's contribution to public policy-making is its involvement in the current development of national energy research strategy. In addition, ANCRE has forged close ties with the French National Research Agency (ANR), which should lead to even stronger interaction between the alliance's strategic recommendations and the agency's programs: ANCRE has already made some recommendations in this respect. Likewise, the alliance has been involved in the development of national and European strategy relating to research infrastructures, the aim being to ensure consistency

for infrastructures in the field of energy. On a European level, it has been particularly active in the preparation of the Horizon 2020 working program and contributed to its mid-term assessment.

ANCRE has begun a major project aimed at uniting and mobilizing the research community around basic sciences for energy in order to prepare the breakthroughs of the future. Collaboration with other national research alliances will be a priority, since the contributions of human and social sciences, environmental sciences and digital sciences and technologies are essential for a successful energy transition. On a European level, new synergies with the European Energy Research Alliance (EERA) need to be promoted.

Identifying the challenges of the future, contributing to public policy-making, guiding research programs, and structuring and uniting communities depend on the production of world-class knowledge. Such knowledge can be provided by an alliance that is made up of 19 research and university institutions, harnessing the skills and expertise of more than 200 energy specialists. I would like to take this opportunity to thank them for their commitment and the quality of their work, demonstrated by the numerous requests submitted to ANCRE and the progressive development of its theme-based Technology Transfer Consortium, which has just been renewed by the French General Commission for Investment for a period of three years.

At ANCRE's annual general meeting in June 2015, the public authorities highlighted the essential role played by the alliance today in the French Research and Innovation System (SFRI). They recommended that its contributions to support the State's strategic reflection processes be continued, along with the broad dissemination of its research so that ANCRE can play an increasing role in representing France's position in this field. There is no doubt that ANCRE is already well on the way to achieving these objectives today.



GOVERNANCE

COORDINATION COMMITTEE

Founding member representatives

IFPEN

Didier Houssin
Chairman

CEA

Christophe Gégout
Deputy Chairman

CPU

Jacques Bittoun
Honorary President of the University
of Paris-Sud

CNRS

Jean-Yves Marzin
Director of the Institute for Engineering
and Systems Sciences

Associate member representatives

Pierre Toulhoat

Deputy Chief Executive Officer,
Scientific Director of BRGM

Yann Mace

Deputy Managing Director, in charge
of financial and legal affairs, purchasing
and IT at INERIS

State Representatives

Michel Ferrandery

Deputy Director of the Transport
Equipment, Machinery and Energy
Division at the General Directorate for
Enterprise, at the Ministry of Economy
and Finance

Frédéric Ravel

Scientific Director of the Energy,
Sustainable Development, Chemistry
and Processes Sector of the General
Directorate for Research and Innovation,
French Ministry for National Education,
Higher Education and Research

Richard Lavergne

Advisor to the Director General for Energy
and Climate and Energy-climate Advisor
to the General Commissioner for
Sustainable Development, Ministry of
the Environment, Energy and the Sea

Funding agency representatives

Pascal Bain

Scientific Manager of ANR challenge 2: "Clean,
secure and efficient energy" and Joint Manager
of challenge 6 "Sustainable mobility and urban
systems", Deputy Manager of the Physics,
Engineering, Chemistry, Energy Scientific
Department of the ANR

Daniel Clément

Assistant Scientific Director of ADEME
(the French Environment and Energy
Management Agency)

Other personalities

Hervé Bernard

Chairman of the European Energy Research
Alliance

Marie-Françoise Chabrelie

Head of the Economics and Information Watch
and Management Division at IFPEN, Director
of ANCRE's theme-based Technology Transfer
Consortium

Sherpa group

CEA (Franck Carré, Françoise Touboul),
CNRS (Alain Dollet),
CPU (Fabrice Lemoine),
IFPEN (Jean-Jacques Lacour),
Associate members (Sylvie Gentier)

LEADERSHIP OF PROGRAMMATIC GROUPS

PG1 - Energy from biomass:

INRA (Paul Colonna), CEA (Elisabeth Le Net),
CNRS-CPU (Jack Legrand), IFPEN (Jean-Luc Duplan)

PG2 - Fossil energy, geothermal energy, critical metals:

IFPEN (Pierre Le Thiez), CNRS (Olivier Vidal)

PG3 - Nuclear energy:

CEA (Franck Carré), CNRS (Sylvain David)

PG4 - Solar energy:

CEA (Philippe Malbranche), CNRS (Gilles Flamant)

PG5 - Ocean, hydraulic and wind energy:

IFREMER (Chantal Compère), École centrale de Nantes-CNRS
(Pierre Ferrant), IFPEN (Thierry Becue)

PG6 - Transports:

IFSTTAR (Guillaume Uster), CEA (Paul Lucchese),
IFPEN (Richard Tilagone)

PG7 - Buildings:

CSTB (Hervé Charrue), CPU- CNRS (Francis Allard)

PG8 - Industries and agriculture:

CNRS (Jean-Michel Most), IFPEN (Laurent Forti)

PG9 - Energy forecasting and economics:

CEA (Jean-Guy Devezeaux), CNRS (Patrick Criqui),
IFPEN (Nathalie Alazard-Toux)

PG10 - Energy networks and associated storage:

CPU (Nouredine Hadj-Said), CEA (Nicole Mermilliod),
CNRS (Michel Latroche)

LEADERSHIP OF CROSS-DISCIPLINARY GROUPS

CG - Strategy:

CEA (Jean-Philippe Bourgoin), CNRS (Pascal Brault),
CPU (Fabrice Lemoine), IFPEN (Jean-Jacques Lacour)

CG - Europe and international:

CEA (Jean-Philippe Gouy), CNRS (Alain Dollet, Pascal Brault),
CPU (Fabrice Lemoine), IFPEN (Julie Lhomme-Maublanc,
Yolande Rondot)

LEADERSHIP OF THE THEME-BASED TECHNOLOGY TRANSFER CONSORTIUM

Founding member representatives:

IFPEN (Marie-Françoise Chabrelie, Director), CEA (Tony Prézeau),
CNRS (Laurence Musset), CPU (Jack Legrand)

Representatives from three associate members:

BRGM (Dominique Morin), IFSTTAR (Guillaume Uster),
IRSTEA (Véronique Vissac), acting on behalf of the other members
of the Consortium (CSTB, IFREMER, INERIS, INRA)

MAIN CHANGES IN 2015-2016

SEPTEMBER 2015

Didier Houssin, Chairman of IFPEN, appointed Chairman of ANCRE. Didier Houssin succeeds Jacques Bittoun, President of the University of Paris-Sud, who had held this post since 17 October 2013 on behalf of the CPU.

FEBRUARY 2016

Renewal of associate member representatives in the ANCRE coordination committee: Pierre Toulhoat (BRGM, full) and Yann Mace (INERIS, deputy) succeeding Vincent Laflèche (BRGM). Sylvie Gentier (BRGM) succeeds Hélène Le Du (IFSTTAR) as associate member sherpa.

OCTOBER 2015

Participation of the French Ministry for the Economy and Finance – represented by Michel Ferrandery – in ANCRE's coordination committee.

JULY 2016

Marie-Françoise Chabrelie (IFPEN) succeeds Françoise Fabre (CEA) at the head of the theme-based Technology Transfer Consortium.

NOVEMBER 2015

Modification of ANCRE's founding convention: qualification and reinforcement of the chairman's role.



KEY FIGURES

4 FOUNDING MEMBERS



15 ASSOCIATE MEMBERS



4

MAJOR MISSIONS

▲ **Reinforce synergies and partnerships** between research bodies, universities and companies concerned by the energy sector

▲ **Identify scientific and technical challenges** hampering industrial development

▲ **Propose research and innovation programs** and approaches to their implementation

▲ **Contribute to the development of national research strategy** in the field of energy, as well as funding agency program development in this area

2

MAIN SOCIETAL CHALLENGES

▲ **Clean, secure and efficient energy**
▲ **Sustainable mobility and urban systems**

10

PROGRAMMATIC GROUPS

▲ Energy from biomass
▲ Fossil energy, geothermal energy, critical metals
 ▲ Nuclear energy
 ▲ Solar energy
▲ Ocean, hydraulic and wind energy
 ▲ Transport
 ▲ Buildings
▲ Industries and agriculture
▲ Energy forecasting and economics
▲ Energy networks and associated storage

200

SCIENTISTS MOBILIZED

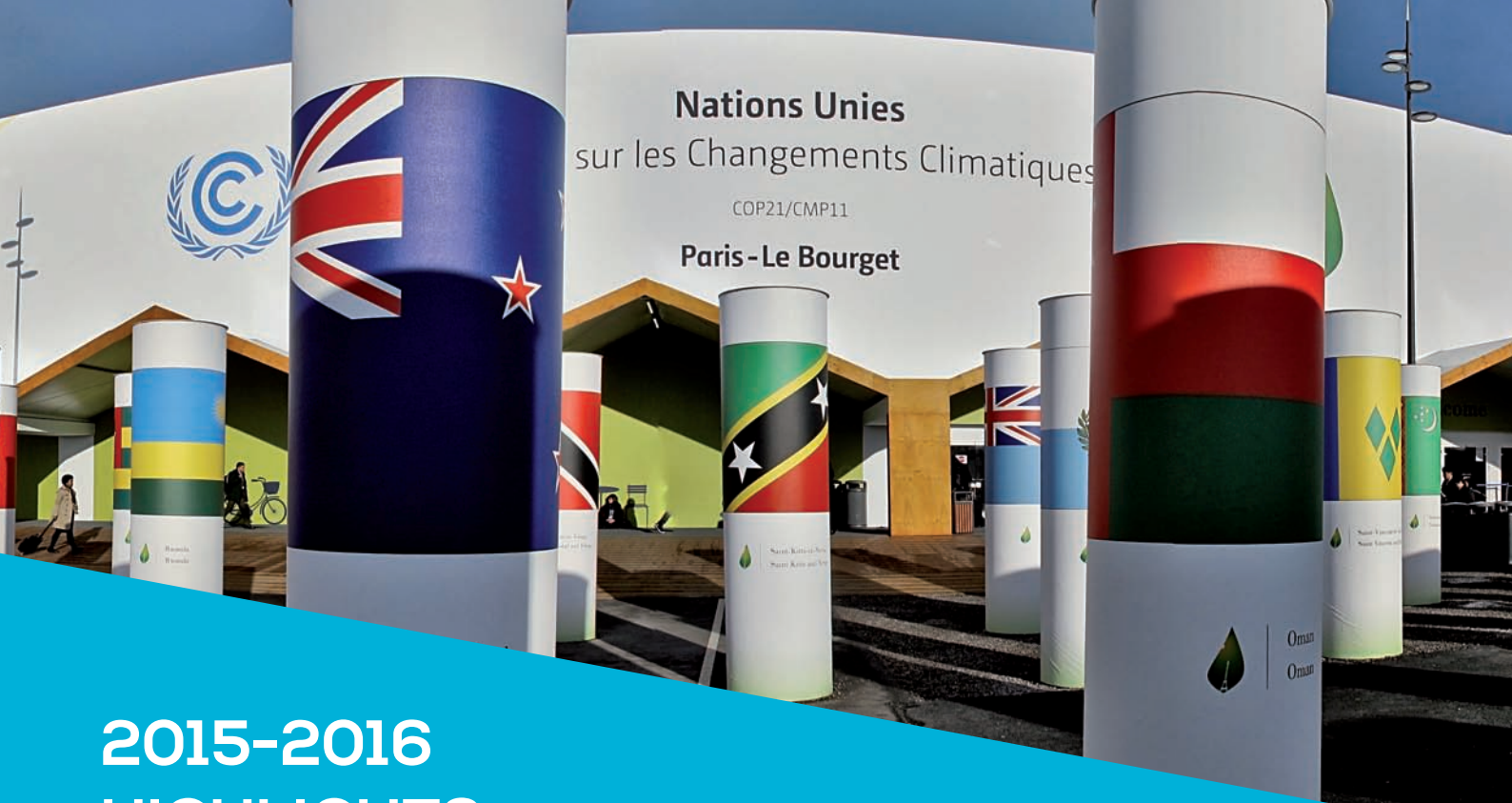
2

CROSS-DISCIPLINARY GROUPS

▲ Strategy
▲ Europe and international

1

THEME-BASED TECHNOLOGY TRANSFER CONSORTIUM



2015-2016 HIGHLIGHTS

June 2015

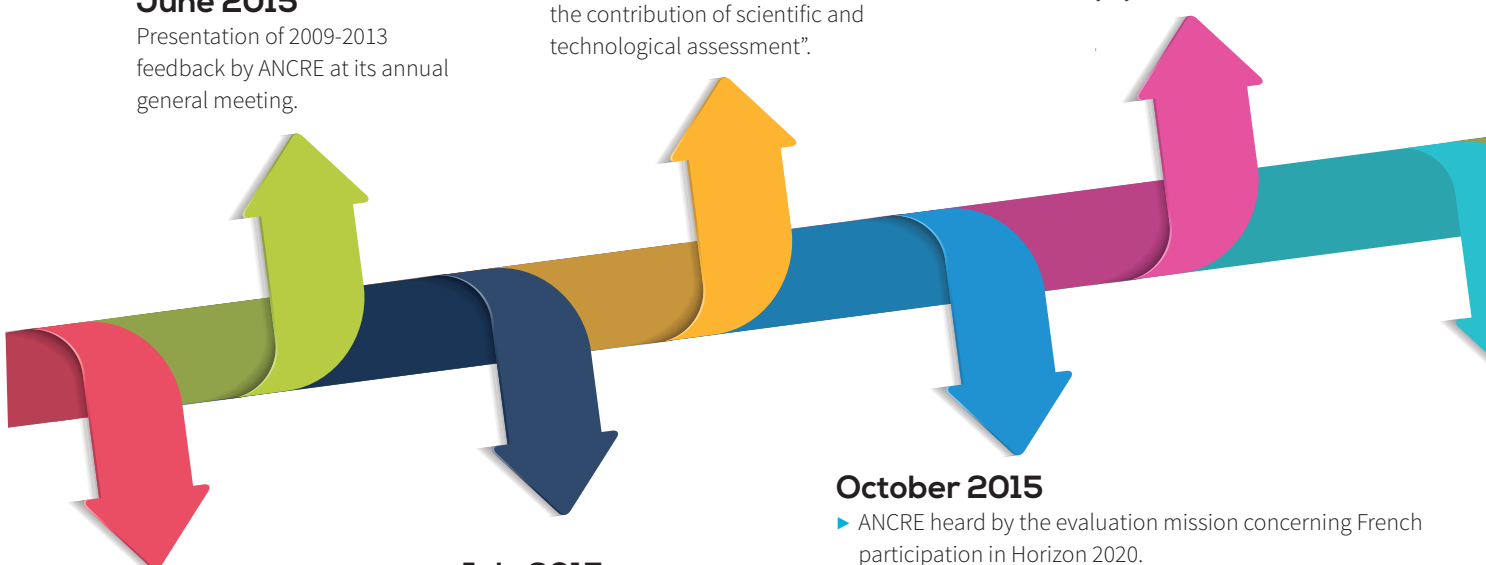
Presentation of 2009-2013 feedback by ANCRE at its annual general meeting.

September 2015

ANCRE heard at the French Parliamentary Office for Scientific and Technological Choices (OPECST) on the subject of "Innovation and climate change: the contribution of scientific and technological assessment".

November 2015

Publication of the Decarbonization Wedges study by ANCRE.



March 2015

Introduction and structuring of the "Europe and international" cross-disciplinary group, hinged around three main missions: European Energy Research Alliance (EERA), European Community and international cooperation.

July 2015

Participation of ANCRE in the scientific conference on the theme of "Our common future under climate change", held at UNESCO in the lead up to COP21.

October 2015

- ▶ ANCRE heard by the evaluation mission concerning French participation in Horizon 2020.
- ▶ ANCRE heard by the International Energy Agency (IEA) evaluation mission on the theme of a "Full analysis of the energy policy of France".
- ▶ Launch of a reflection process relating to "Basic sciences for energy" aimed at assembling and organizing an academic community of basic sciences to prepare for the breakthroughs of tomorrow in the field of energy.
- ▶ Symposium on "The 2°C pathway: what can low-carbon technologies contribute?" held at the Ministry for National Education, Higher Education and Research.



January 2016

- Symposium on “Heat in the energy transition: challenges and priorities for research” organized by ANCRE at the Ministry for National Education, Higher Education and Research.
- ANCRE heard at the three-yearly assessment of the theme-based Technology Transfer Consortium.
- Joint ANCRE-Athena hearing at the OPECST on “Synergies between human sciences and technological sciences”.

March 2016

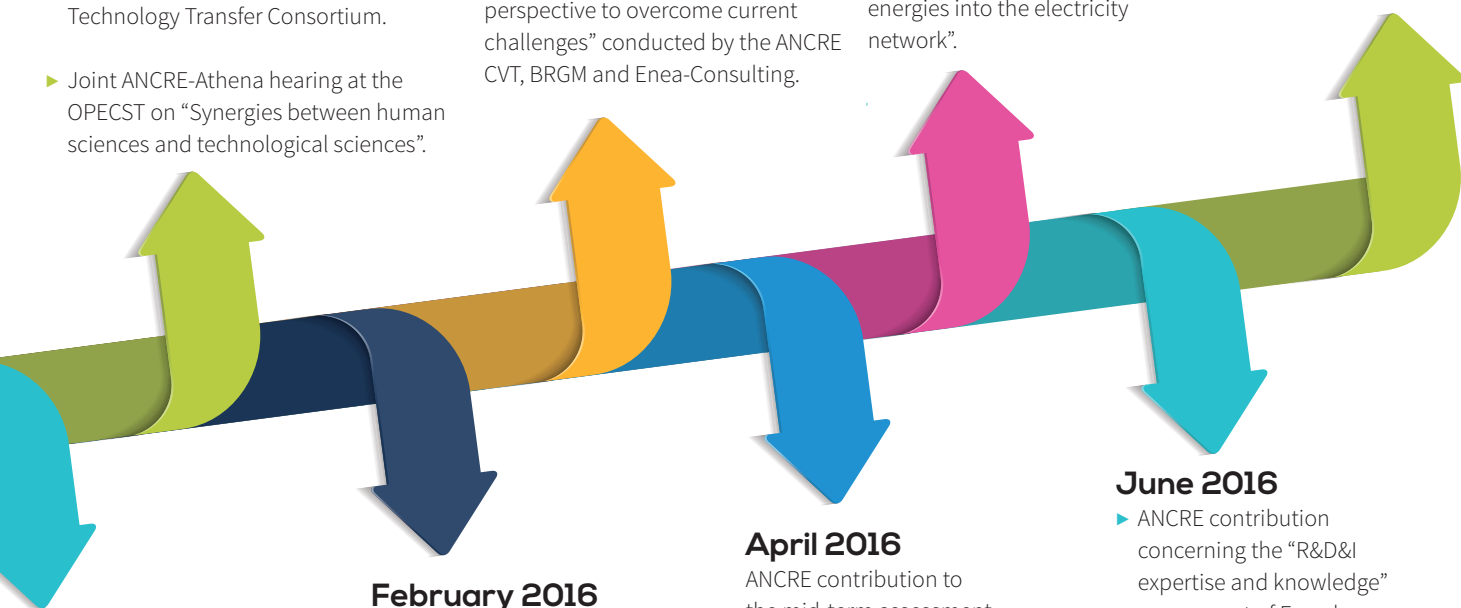
Symposium to report the results of the study on “Underground energy technologies: what shared perspective to overcome current challenges” conducted by the ANCRE CVT, BRGM and Enea-Consulting.

May 2016

ANCRE heard at the OPECST on “The technological challenges of incorporating renewable energies into the electricity network”.

September 2016

Renewal by the CGI of funding of the ANCRE CVT for a period of three years.



December 2015

Participation of ANCRE in COP21 via the organization of two side-events concerning the “Hydrogen system: a significant role in the energy transition?” and presentation of the Decarbonization Wedges study.

February 2016

ANCRE recommendations concerning the strategic positioning of the French National Research Agency (ANR), particularly in the fields of sustainable energy, mobility and urban systems, and on its program-setting process.

April 2016

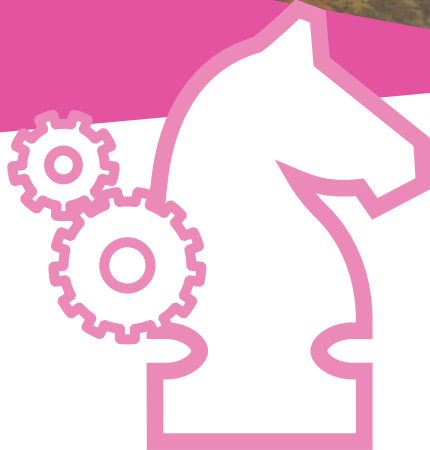
ANCRE contribution to the mid-term assessment of the Horizon 2020 program.

June 2016

- ANCRE contribution concerning the “R&D&I expertise and knowledge” component of French National Energy Research Strategy or SNRE.
- ANCRE heard at the OPECST on the subject of “Research valorisation”.



IDENTIFYING FUTURE CHALLENGES



A STRONG COMMITMENT WITHIN COP21

In the context of the 21st Conference of Parties (COP21), ANCRE led a reflection process examining the key technological levers to significantly reduce the carbon footprint of the world's energy system by 2050 and to limit global warming to 2°C in 2100.

PG9 thus analyzed the solutions highlighted by the decarbonization pathways developed for the planet's 16 biggest CO₂ emitting countries as part of the UN's Deep Decarbonization Pathways project. In addition, all of ANCRE's PGs identified the technologies – currently being developed or still at the research stage – that might contribute to reducing greenhouse gases and evaluated their potential for cutting CO₂ emissions.

To avoid emitting 40 to 45 billion tonnes of CO₂ in 2050, the conclusions start by highlighting the need to mobilize a broad portfolio of technologies; more than one hundred such technologies have thus been identified, with variable scopes and levels of implementation depending on the country groups studied. The reduction potential depends as much on technologies relating to the energy offer (wind, solar, nuclear, CO₂ Capture and Storage (CCS),

biomass, etc.) as on those relative to demand (transport, industry, buildings) and the results converge in terms of the technologies offering the greatest CO₂ reduction potential.

In the field of energy production, solar, wind and nuclear technologies lead the way in all the country groups studied, with overall reduction potentials of 10%, 9% and 8% respectively. Then come hydraulic power (primarily in southern countries), biomass, geothermal and ocean energies. While CCS also plays an essential role, its significance is perceived differently depending on the approach used, with a reduction potential assessed at between 5% and 15%. In terms of energy efficiency and substitution by carbon-free, renewable sources (electricity, hydrogen, biofuels, etc.), the main savings opportunities can be found in the industrial sector (25% of total world reduction) and in transport (19%). In buildings, the opportunities appear to be real but less significant (9%).



Furthermore, ANCRE's analyses reveal three main types of obstacles hampering the development of low-carbon technologies:

- ▶ on an economic level, the risks of new energy technologies not being competitive enough and a lack of capacity to fund solutions that often remain highly capital intensive;
- ▶ on a regulatory level, the real obstacle represented by inappropriate, ineffective and often frequently changing regulations;
- ▶ in terms of research, the overall lack of adequate R&D investment in the field of energy considering the stakes involved.

To speed up the roll-out of low-carbon technologies, ANCRE has formulated a number of recommendations:

- ▶ support world R&D efforts to improve the competitiveness of existing technologies and develop disruptive technologies;
- ▶ incorporate the human and social dimension from the outset of the innovation process in order to provide solutions that meet the needs of public authorities, territories and civil society, and propose changes in types of governance for better deployment of new energy technologies;
- ▶ introduce mechanisms enabling technology transfer from industrialized countries to less developed regions;
- ▶ pay particularly close attention to regulatory aspects and standards.

These analyses led to publication of the Decarbonization Wedges report and a set of technological data sheets available on the ANCRE website. In addition, a symposium to report the results, entitled "The 2°C pathway: what can low-carbon technologies contribute?" was held on 16 October 2015 at the Ministry for National Education, Higher Education and Research. This symposium, which brought together some one hundred participants, was an opportunity for fruitful discussions between researchers and industrial players concerning the roll-out prospects for low-carbon technologies over various time frames, and to outline the public policies and necessary collaborations that would help speed up this roll-out.

This study was also presented at a conference organized at the French Pavilion at COP21 on 11 December 2015, helping to shed light on possible action levers that could be employed to translate the commitments made by the countries in Paris into reality. Today, it has been submitted to a number of bodies (Ministry of the Environment, Energy and the Sea (MEEM) — Directorate General for Energy and

Climate (DGEC), MEEM — General Council for the Environment and Sustainable Development (CGEDD), French Academy of Sciences, Enterprise for the Environment association, OPECST hearing, etc.) helping to enrich its content and guide future reflection.

Similarly, ANCRE organized a second conference at the French Pavilion of COP21 on the theme of the "Hydrogen system: a significant role in the energy transition?". Hydrogen plays a role as an energy vector in several pathways aimed at significantly reducing the CO₂ emissions of the world energy system. The conference was an opportunity to compare the various viewpoints of research and industry players concerning the potential of hydrogen and the key factors in its roll-out, by reviewing all the possible applications in the field of mobility, energy storage or the management of electricity networks.

Finally, ANCRE took part in the international scientific conference on the theme of "Our common future under climate change", held at UNESCO in Paris, from 7 to 10 July 2015. Organized in the lead up to COP21, the event aimed to review current scientific knowledge in the area and draw up solutions to address the challenge of climate change. The work carried out by ANCRE on Decarbonization Wedges and its recommendations to speed up the development and dissemination of low-carbon energies around the globe were presented by PG9 on 10 July at the Low Carbon Pathways for Staying Below 2°C: National Contributions session.





Heat management: a major challenge in the energy transition

On 21 January 2016 a symposium was organized by ANCRE's theme-based Technology Transfer Consortium (CVT) and several ANCRE Programmatic Groups on the theme of "Heat in the energy transition: challenges and priorities for research".

This symposium, attended by some 200 participants, examined the challenges posed by heat, a central factor when it comes to reducing energy consumption and improving energy efficiency. Since it accounts for 45% of energy consumption in France, there is a considerable margin for progress in the use of heat resulting from industrial activities and energy production.

The various presentations and debates confirmed the strategic importance of heat — already highlighted in ANCRE's scenarios — in terms of preparing technological breakthroughs with a major potential impact on the energy transition.

The state of the art drawn up also revealed France's strengths in this area. Finally, the testimonials of industrial players helped to highlight the challenges that scientific and technical communities need to address in order to recover and convert the vast potential of waste heat at all levels of processes and in all sectors, the resolution of these problems being one of the key elements involved in ensuring the competitiveness of the industrial sectors concerned.

A SIGNIFICANT INVESTMENT IN NATIONAL FORECASTING SCENARIOS

In 2016, ANCRE began constructing new energy scenarios for France up to 2050, the aim being to propose a set of pathways best satisfying the various targets and actions indicated in French energy transition for green growth legislation (LTECV) and taking into account the actions and strategies indicated in the long-term energy program (PPE), as published in 2016.

In this context, PG9 developed a tool providing an integrated representation of the national energy system and all its usages (building, transport, industry, agriculture). The tool, named Opéra, incorporates the various technology groups and their performance, as well as the changing behaviors of stakeholders. All of ANCRE's Programmatic Groups participated in this forecasting exercise, bringing their own particular expertise concerning the expected performance of the main technologies required by the energy transition and the innovations that might emerge and be rolled out between now and 2050. Work currently underway includes a more in-depth multi-criteria assessment of pathways as an extension of research already carried out during previous exercises, with a determination to develop close cooperation with other alliances (AllEnvi*, Athena**), who have an essential contribution to make in this area.

By continuing and updating its work on energy scenarios for France and by consolidating this activity via the construction of an integrated tool to represent the energy system, ANCRE is determined to make an active and lasting contribution to France's long-term energy program and to gradually become a prominent player in all questions related to the energy transition.

THE ENERGY TRANSITION for the
GREEN GROWTH

*French National Alliance for Environment Research

**French National Alliance for the Social Sciences and Humanities



CONTRIBUTING TO PUBLIC POLICY-MAKING



A RECOGNIZED CONTRIBUTION TO THE NATIONAL DEBATE ON THE ENERGY TRANSITION

Determined to play a full role in the National Debate on the Energy Transition, in 2013, ANCRE developed three scenarios for the evolution of the French energy system up to 2050. These three pathways shared a common goal: to enable, by 2050, a 4-fold reduction (compared to 1990) in greenhouse gas (GHG) emissions in the energy sector, with a constraint of reducing the share of nuclear energy in national electricity production to a maximum of 50% by 2025-2030. In addition, an alternative scenario was also studied, whereby the proportion of nuclear production remained stable but incorporating the implementation of nuclear cogeneration and a significant increase in the share of renewable energies in the energy mix.

After two years of work involving all its Programmatic Groups, in 2014, ANCRE published a report describing these three pathways and the “nuclear and renewable energies” variant, along with the results of an initial multi-criteria assessment of each one, focusing more specifically on the socio-economic and environmental impacts. *Via* this

publication, ANCRE wanted to provide additional clarifying information in the context of the preparation of draft French energy transition for green growth legislation (LTECV).

The economic assessment performed highlighted the need for considerable investment. This result is true for all the scenarios, without any significant difference being identified between them. Along with the reduction in GHG emissions, several other positive impacts were measured, primarily concerning a reduced reliance on external energy, an improved trade balance and, potentially, a positive effect on employment. With respect to the latter point, however, it is still crucial that the emergence of new technological sectors be supported by public investment and developed by French and/or European companies.



In addition, the per-unit prices for energy increase in all the scenarios, but at varying rates. Generally speaking, a doubling of the price of electricity is expected between now and 2050. However, the impact on household budgets and costs to companies could broadly remain limited, given significantly reduced energy consumption. Finally, this report outlines a number of proposals in terms of research programs, concerning, in particular, the intensity of R&D efforts required and the steering methods to be implemented, in liaison with national energy research strategy.

With respect to the multi-criteria assessment of these scenarios, ANCRE highlighted the need to reinforce and extend this research over the long-term, given the complexity of the issues raised, the uncertainties involved and the real potential of current modeling tools.

This study has been the subject of numerous presentations and debates with the public authorities and all stakeholders in the National Debate on the Energy Transition (industrial players, elected representatives, associations, etc.), thus making a full contribution to the public debate by providing information to help understand the potential impacts of the various strategies that could be envisaged and the innovations to be implemented.



Contribution of ANCRE to the reflection process relating to participatory sciences in France

The concept of participatory sciences covers activities that get the general public involved in scientific projects, with the public producing data for scientists, in turn responsible for expressing the need, interpreting the data and producing the scientific knowledge to which this data contributes.

François Houllier, Chairman and CEO of INRA and Chairman of the AllEnvi alliance, was tasked by the Ministry for National Education, Higher Education and Research to carry out a project in this area, for which the various alliances were consulted and, in particular, ANCRE, which contributed a report submitted to Najat Vallaud-Belkacem and Thierry Mandon on 4 February 2016.

The participatory science approach is not widely used in the energy field. It is more generally applied to sectors related to energy demand than to energy supply, except when the latter is accessible to individuals, as is the case with solar energy, for example. However, ANCRE has identified a few initiatives, such as the photovoltaic sites database (BDPV) for energy supply, and the Efficient driving of electric vehicles project (CEVE) for demand.

SUSTAINED INVOLVEMENT IN THE DEVELOPMENT OF NATIONAL ENERGY RESEARCH STRATEGY

Article 183 of law 2015-992 of 17 August 2015 concerning the energy transition for green growth (LTECV) stipulates that “the ministers for energy and research decree and make public a National Energy Research Strategy (SNRE), which constitutes the energy component of the National Research Strategy (SNR)”. A first SNRE was developed in 2007. Launched in 2012, work to revise the SNRE was suspended pending the strategic orientations resulting from the National Debate on the Energy Transition (DNTE) and French Energy Transition for Green Growth Legislation (LTECV).

The capacity to carry out technical and economic forecasting studies and to subsequently use these as a basis for drawing up strategic priorities and R&I roadmaps is one of ANCRE’s strengths, as illustrated by its contribution in 2013 to the development of the national research strategy in response to the societal challenge of “clean, secure and efficient energy”. Based on ANCRE’s development of three scenarios designed to achieve a 4-fold reduction by 2050, five themed priorities were defined by ANCRE:

► **priority 1:** accelerate R&D work on the invariants of the energy transition scenarios, including optimization of the energy system, a significant reduction in final energy consumption and the development of a competitive renewable energies offer;

- **priority 2:** build on the competitive strengths of the sectors currently dominant in the French energy mix and of industries contributing to energy security (oil and gas, nuclear, strategic mineral resources);
- **priority 3:** promote technological revolutions with a potentially high impact on the energy transition (CO₂ capture, transport, storage and conversion, waste heat management);
- **priority 4:** improve our understanding of energy use behaviors and develop appropriate market models in a context of a complete overhaul of players' roles and value chains in the energy sector;
- **priority 5:** promote the emergence of innovative concepts for energy, developing a core of world-class fundamental and generic knowledge and boosting the drive to transform fundamental research into technological breakthroughs (implementation of sustainable themed multidisciplinary networks, development of programs encouraging generic and cross-disciplinary approaches, such as big data or based on human and social sciences [economics, sociology, psychology, philosophy, history, law], etc.).

In January 2015, this contribution was used to help produce a first draft of the National Energy Research Strategy (SNRE) within its permanent secretariat, of which ANCRE is a member alongside the Ministry of the Environment, Energy and the Sea, the Ministry for National Education, Higher Education and the Research and ADEME. In this context, a further two contributions were supplied by ANCRE as preparatory documents for the SNRE:

- updating in January 2016, of the 16 energy technologies data sheets (drawn up in 2012 with ADEME) presenting a factual inventory of the current situation for the different energy technologies: state of the art, expertise and players, economic development potential, etc.;
- a reflection process, in June 2016, focusing, firstly, on the advantages and organization of a top-level national research community in the field of energy and its interaction modes with companies and, secondly, the training of energy transition players and the dissemination of knowledge to civil society.

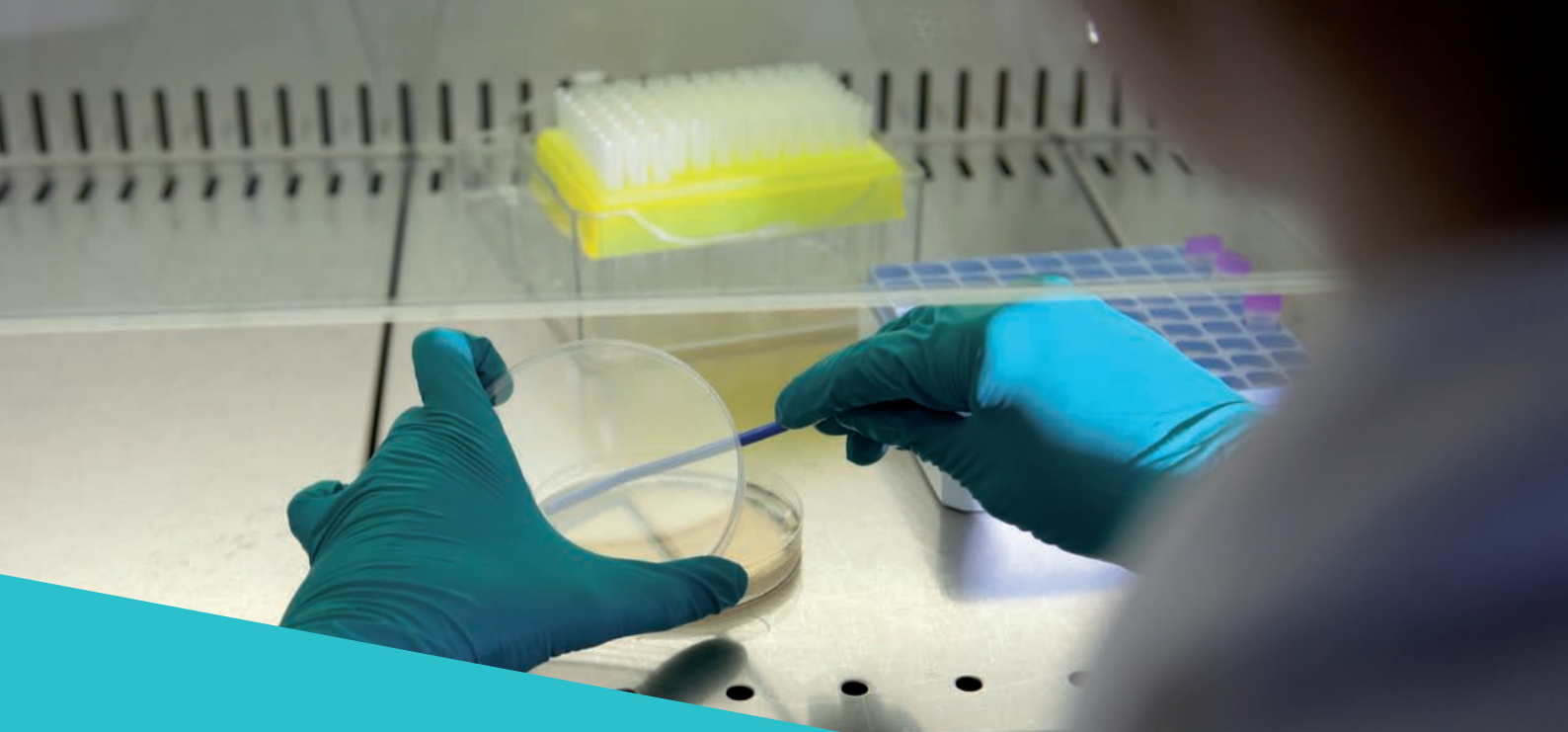
For the first component, a number of recommendations were put forward, highlighting, in particular, the need for systematic structuring of new energy sectors (including the amplification of regional actions on demonstrators), support for company start-ups by young graduates and researchers and greater complementarity between the actions of the main public research operators, to be

Hearing of ANCRE by the International Energy Agency

ANCRE presented its view at the “In-depth review of the energy policy of France” conducted by the International Energy Agency (IEA) from 19 to 23 October 2015. The specific political and diplomatic significance of this exercise should be highlighted, since the aim was to adopt a “peer review” methodology to verify France’s compliance with the IEA membership treaty. The hearing was an opportunity to highlight the importance of the coordinating role played by ANCRE within the French Research and Innovation System and to discuss ANCRE’s contribution to the implementation of the H2020 program and its relations with the EERA. Its role in, and contribution to the development of the National Research Strategy (SNR) and the ANR’s program development process, particularly with respect to challenge 2 “clean, secure and efficient energy”, were also emphasized by the Ministry for National Education, Higher Education and Research, which also presented its view at this hearing.

promoted, more specifically, in the context of their contractualization processes with the State. Similarly, factors contributing to the emergence of an “upstream” cross-disciplinary research community have been advanced, highlighting, in particular, the importance of close cooperation between alliances and the long-term implementation of a “Basic sciences for energy” research program, along the same lines as similar initiatives adopted by the Department of Energy (USA) or the EERA (particularly as part of the Advanced Materials and Processes for Energy Applications (AMPEA) program, which aims to create a European research network and increase the efficiency of the resources allocated by Member States).

With respect to training, the increasingly cross-disciplinary approach of programs (Masters), the adaptation of programs to specific disciplinary fields, the complementarity of undergraduate, continuing training and research-based programs, the need to foster an entrepreneurial spirit among students and the promotion of ambitious educational innovation strategies have been recommended.



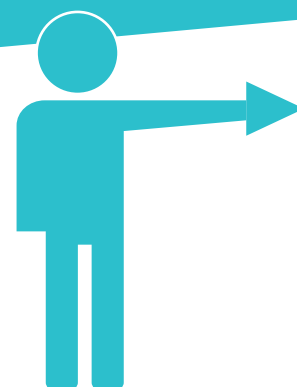
GUIDING PROGRAM DEVELOPMENT

CLOSE COOPERATION WITH THE FRENCH NATIONAL RESEARCH AGENCY

As a qualified expert, an ANCRE representative sits on the board of the French National Research Agency (ANR). ANCRE is also represented in the scientific steering committees for challenges No. 1 “Efficient resource management and adaptation to climate change”, No. 2 “Clean, secure and efficient energy”, No. 3 “Industrial renewal” and No. 6 “Sustainable mobility and urban systems”.

Supported by its ten Programmatic Groups, ANCRE actively contributes to the development of the ANR’s action plan by proposing the changes desired each year. For example, ANCRE proposed the introduction of axis 1 of challenge No. 2 relative to “Fundamental and exploratory research and disruptive concepts”, in order to reinforce fundamental and generic knowledge and promote cross-disciplinary research, two crucial drives essential to preparing the technological revolutions required in the medium to long term by the energy transition.

Furthermore, in response to a steady reduction in the funding allocated to challenges No. 2 and No. 6, ANCRE presented a number of proposals to the ANR in February 2016.



ANR

In fact, the ambitious objectives set by public policies in the field of energy and clean mobility (LTECV, 2030 Energy-Climate package, launch of the Innovation Mission at COP21, etc.) make it necessary to reconsider the public funding of R&I in these fields, both in terms of volume and the financial instruments to be adapted or created, with a view to ensuring complementarity (ADEME, H2020 program, structural funds, etc.), transparency and simplification.



In this context, ANCRE more specifically recommends:

- ▶ producing an inventory (to be continuously monitored), including an international benchmark, of existing funding and public financial instruments for R&I in the energy sector;
- ▶ targeting allocations for each specific challenge and regulating them, taking into account complementary criteria, such as the size of the communities concerned or the number of partners or researchers involved per project, so that the number of preliminary projects submitted is not the only criterion for allocating resources for each challenge and main priority;
- ▶ stepping up and consolidating the ANR's research efforts in the area of "Basic sciences for energy (low-TRL)" in order to promote the emergence of breakthroughs/innovative concepts in this field;
- ▶ reinforcing the strategy-program link between ANCRE and the ANR, protecting the funding of the themes/strategic orientations proposed by ANCRE on the basis of criteria and methods that remain to be defined;
- ▶ clarifying the position of the ANR relative to the relevance of a focus, *via* agency funding, on public-private links in the field of energy, in particular through collaborative research projects with companies;
- ▶ reserving a share of the ANR's budget to enable national participation in joint European programming initiatives, in particular existing or future ERA-NET Cofund, in the energy field, at the same time increasing France's role in the leadership of these projects.

A COORDINATED ACTION ON RESEARCH INFRASTRUCTURES

ANCRE has played a major role in the construction of national strategy related to research infrastructures with, in particular, the updating of the national roadmap for very large research infrastructures (TGIR) and the European Strategy Forum on Research Infrastructures (ESFRI) roadmap.

For the first time, and with the aim of ensuring consistency on a French and European scale, the national roadmap will include a specific energy component. Six projects have been proposed by ANCRE for approval in the field of energy. Ultimately, and following the recommendation of the TGIR high council, the TGIR steering committee (CD-TGIR), on which the ANCRE Chairman sits, proposed the inclusion of two infrastructures in the roadmap, under the "Research infrastructure" label:



- ▶ **Fr-Solaris:** French research infrastructure for concentrated solar thermal power (French node of the ESFRI EU-Solaris project), led by the CNRS;
- ▶ **WEST:** W (Tungsten) Environment for Steady State Tokamaks (upgrade of the Tore-Supra project at Cadarache), infrastructure led by the CEA.

A further three infrastructures have also been identified in the national roadmap, under the "Project" label:

- ▶ **ECCSEL:** European Carbon Dioxide Capture and Storage Laboratory, the French node of the ESFRI ECCSEL project and infrastructure led by the BRGM;
- ▶ **Sophira:** infrastructure for research in photovoltaic solar energy, led by the CEA;
- ▶ **Theorem:** network of hydrodynamic testing resources for ocean renewable energies, an infrastructure led by the École centrale de Nantes and IFREMER.

ANCRE also participates in the legal structure committee set up at the end of 2014 by the Ministry for National Education, Higher Education and Research to examine research infrastructure applications liable to be selected on a European level.



ACTIVE PARTICIPATION IN EUROPEAN PROGRAMS

Relations with the European Community are one of ANCRE's priorities. In response to low financial returns for French R&D players during FP7 and at the start of the H2020 program, ANCRE presented its views at a hearing held in October 2015 by the evaluation mission concerning French participation in the Horizon 2020 program. Although it is not a research operator, ANCRE was therefore given the opportunity to reiterate its actions with respect to Europe; its role in the preparation of H2020 working programs and the consistency of its proposals with its contributions to the French National Research Strategy (SNR) or the ANR action plan were highlighted.



In April 2016, ANCRE was also consulted by the Ministry for National Education, Higher Education and Research for a mid-term assessment of the Horizon 2020 program. Concrete recommendations were formulated: support for a priority challenge, on the same level as the European Research Council; increased support for the Energy theme of pillar 1 (excellence) of the H2020 program; support for the entire R&D&I chain; reinforcement of targeted actions concerning TRL 3-4; implementation of mechanisms to increase researcher mobility; reinforced project selection (during the first phase); quest for better links between programming initiatives and national funding tools.

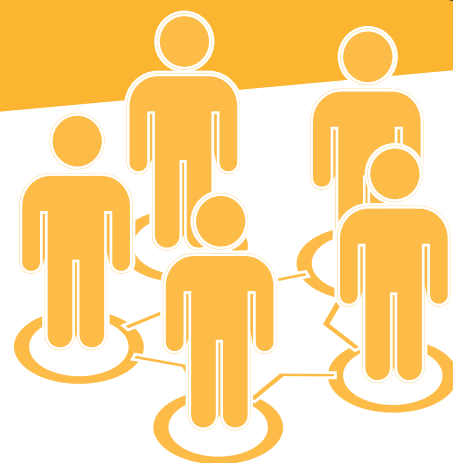
In addition, in the spring of 2016, ANCRE also formulated proposals for the proactive 2018-2020 FET (Future and Emerging Technology) program — electrochemistry of the 21st century; a rational approach for the design of molecules and materials for energy — and passed on to the French representative in program committees a number of topics for the construction of the working program.

Finally, as part of the ANR's reflection process concerning its international policy, ANCRE strongly recommended the agency's financial involvement in future ERA-NET Cofund low-TRL programs and is currently tasked with examining themed proposals.



Chair and secretariat of the EERA

MOBILIZING, STRUCTURING AND UNITING COMMUNITIES



PROMOTING A “BASIC SCIENCES FOR ENERGY” COMMUNITY

ANCRE's contribution to the French national research strategy has focused on the need — as a strategic priority in its own right — to promote the emergence of innovative concepts for energy. To this end and after having identified the existing initiatives and structures of its member organizations in this area (open programs, research groups, incentive actions, etc.), in the second half of 2015, ANCRE launched a reflection process concerning “Basic sciences for energy”. The objective is to bring together and extend a community in this area based on collective intelligence, with a 10 to 15-year research horizon, with a view to preparing for and encouraging the emergence of the scientific and technological breakthroughs of tomorrow, and to constructing an ambitious cross-body program (EPIC*, EPST** and universities) in this field.

The first task was to identify broad, generic and cross-disciplinary issues promoting:

- ▶ the emergence of new concepts (TRL of up to 2-3) via a bottom-up approach;
- ▶ the transposition of high-impact scientific fields to the energy sector;

*French Public Industrial and Commercial Establishment

**French Public Scientific and Technical (Research) Establishment

- ▶ the identification of the medium to long-term needs of industry and their translation into fundamental scientific questions.

At this stage, ANCRE has already identified the following main themes as drivers for significant breakthroughs in the field of energy: multiscale and multiphysical modeling and simulation of materials; innovative materials; advanced characterizations for energy systems; bio-inspired systems; complex and dynamic system sciences of energy-focused systems.

In the coming months, similar initiatives implemented by foreign institutions (Basic Sciences for Energy program of the DOE in the USA, university campuses leading major multidisciplinary “energy” initiatives, etc.) will be identified and analyzed; these will help define the shape of the cross-body research initiatives to be promoted, in close



cooperation with funding agencies. During the second phase, workshops bringing together French and international experts will be organized, hinged around the challenges identified as being the most likely to give rise to breakthroughs, in order to construct the associated roadmaps.

REINFORCED COOPERATION WITH OTHER NATIONAL ALLIANCES

The development of energy systems is dependent on knowledge related to human and social sciences (HSS); consequently, it was a logical step for ANCRE to work with the ATHENA alliance, participating in its board meeting sessions as a guest member.

Since it was created, ATHENA has sought to consolidate and reinforce the human and social sciences community around the subject of energy, creating a forecasting group (GPRO) in this field, which includes ANCRE researchers. In 2015, against the background of COP21, this forecasting group became GPRO Énergie-Climat (Energy Climate forecasting group), and ANCRE's PG9 now contributes to its work. In order to further reinforce the synergies between the two alliances, ANCRE also invited a representative from the ATHENA alliance to take part in the work carried out by PG9.

In January 2016, the OPECST symposium on “Synergies between human sciences and technological sciences” was an opportunity for the two alliances to present their joint actions and make proposals: cross-disciplinary training programs, project selection process, need for multidisciplinary selection juries, interfaces between hard sciences and the numerous human and social science disciplines involved in the energy debate, etc. The need to structure upstream HSS/energy research (beyond the implementation of joint research projects) and to monitor international initiatives were judged to be essential.

On 9 and 10 June 2016, a symposium was also organized at the University of Strasbourg on the theme of “Critical approaches to the energy transition in human and social sciences”, during which the two alliances presented an introductory session entitled “What is the impact of the energy transition on dialogue between disciplines? Feedback from the recent experiences of the ANCRE and ATHENA research coordination alliances”.

In addition, it is important to recall the close cooperation with the AllEnvi (environment) alliance, in particular *via* the joint work carried out by ANCRE's Programmatic Group 1 (biomass) and AllEnvi's Working Group 7 (Ecotechnologies and sustainable chemistry). Similarly, the collaboration started with Allistene (digital sciences and technologies) as part of the development of the French national research strategy is likely to be enhanced in the near future, given the growing importance of interactions between energy and digital technology.

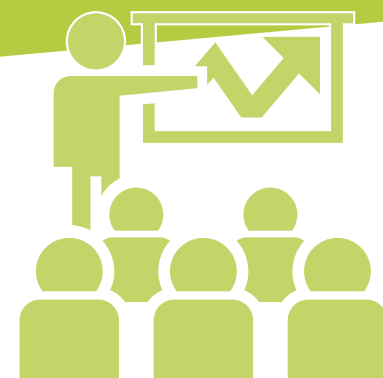
STRONG TIES WITH THE EUROPEAN ENERGY RESEARCH ALLIANCE

Created in 2008, the European Energy Research Alliance (EERA) brings together 175 members from 27 European countries. Eleven of these members are French (BRGM, CEA, CNRS, CSTB, IFPEN, INERIS, INRA, EDF, France Énergies Marines, Mines de Paris and the University of Lorraine). These include the EERA's founding members and four associate members of ANCRE. Since April 2014, France — represented by Hervé Bernard, Director at the CEA — has chaired the executive committee of EERA, a chair that began with the creation of international non-profit organization which leads the activities of the European alliance. To ensure the good circulation of information between the EERA and ANCRE, the EERA Chairman is regularly given the floor during ANCRE coordination committee sessions (with the chairman also being a member of these committees in his own right). The calendar of EERA events, governance questions and the results of its meetings with the European Commission or member states are also the subject of numerous discussions during these meetings and help to reinforce the coherence of the reflection processes and actions of the two alliances.

Finally, in terms of international actions, the structuring of the “Europe and international” cross-disciplinary group in 2014 is beginning to yield results, with a high level of commitment on the part of its founding and associate members to responding to the various questions submitted to it by the Ministry for National Education, Higher Education and Research. For example, the “Europe and international” cross-disciplinary group actively participates in the various working groups and the steering committee set up by the Ministry for National Education, Higher Education and Research in June 2016 as part of the international research, innovation and higher education strategy — SIRIES) development process.



PRODUCING AND DISSEMINATING KNOWLEDGE



PROGRAMMATIC GROUPS MOBILIZED

▲ PG1- Energy from biomass

The objective of ANCRE's Programmatic Group 1 (PG1) is to study the potential of biomass resources and user technologies (heat, cogeneration, biogas [methanization and methanation], biofuels). The group works very closely with the AllEnvi alliance's Transversal Group 7 (TG7) for Ecotechnologies and sustainable chemistry. What is specific about these two groups is that the starting point for all their reflection processes is biomass. The latter is a generic term that covers agricultural, forestry and aquatic products, byproducts and waste from biological matter processing industries (sawmills, paper mills, agrifoods industries, livestock farming industries) and other organic waste (urban waste, water-treatment plant sludge, household waste, green waste from parks and gardens), including waste from energy crops.

A roadmap on "Bioenergies and sustainable chemistry" will soon be finalized. This roadmap is structured around a number of components, the first of which concerns the availability and mobilization of the resource. The challenge

is to determine the potential for the widespread use of technological solutions, in view of the territories where biomass resources are available. In some cases, the resource needs to be treated: the technical and scientific problems and all the technologies involved in the modification of biomass are analyzed, along with processes reducing biomass to its component elements, from the particulate scale to monomers, by a combination of physical, chemical and biotechnological technologies. This roadmap also tackles biological conversion using microorganisms or microbial and (bio)chemical consortia, or *via* the use of catalysts. There is a particular focus on the development of system approaches, in terms of both territorial and plant organization. Finally the scientific and technological challenges to be overcome throughout the chain — in a European context especially — are explicitly set out.



PG1 also organized two symposia with ANCRE's Technology Transfer Consortium (CVT): one on the subject of "Microalgae: a new industrial sector", in Saint-Nazaire on 22 and 23 October 2015; the other on the "Organization of biomass for the energy sector. What opportunities for economic players? The case of forestry biomass", in Lyon on 17 March 2016.

Finally, two new studies were launched in 2016 in the context of the CVT: one concerning "Biological conversions: alternatives to methanization" and the other concerning the "Production of bio-oils".

▲ PG2 - Fossil energy, geothermal energy, critical metals

The work of Programmatic Group 2 led to the publication of two reports:

- ▶ The first, entitled "Mineral resources and energy" reviews the scientific and technological challenges associated with the issue of procuring strategic raw material supplies, taking into account the requirements of the energy transition. It illustrates the links between these two sectors and reviews the main R&D avenues that should be the focus of dedicated national and international programs. The report was presented to the Ministry of the Environment, Energy and the Sea on 19 January 2016.
- ▶ The second, commissioned by the interministerial center for forecasting and anticipating economic trends and changes (Pipame) and entitled "Challenges and opportunities for industrial sectors for deep underground

energy recovery", was researched by the ANCRE CVT, the BRGM and ENEA Consulting.

The aim of this study is to make a quantitative and qualitative diagnosis of the players in these sectors — oil and gas exploration and production, geological storage of hydrocarbons in liquid and gas forms, geological storage of CO₂ and deep geothermal energy — present on the French territory, and their structure. These sectors present a number of strong similarities but different levels of maturity; they require the implementation of synergies to ensure rapid performance gains. Three types of recommendations (divided into eight levers) were identified for winning new export markets, to consolidate French expertise and to construct a responsible and sustainable operating model for the deep underground environment and promote the strengths of these sectors in order to firmly anchor jobs in France. The report led to a specific symposium, organized as part of the "Les rendez-vous du Pipame" events, on 11 March 2016.

Also of note was the participation of Programmatic Group 2 in the working group set up by the Ministry for National Education, Higher Education and Research and the Ministry for the Economy and Finance, in the context of the research, innovation and development strategy in the raw materials sectors (mineral and organic).

▲ PG3 - Nuclear energy

Programmatic Group 3's actions focused primarily on reinforcing cooperation with the academic community (low-TRL research), on the contribution of nuclear energy to a low-carbon economy and on the examination of topical issues.

For the first point, PG3 concentrated on exploring new opportunities for cooperation in the field of neutronics. In addition, two roadmaps are currently being developed concerning "Instrumentation for nuclear energy" and "Thermonuclear fusion".

For the second point, the contribution of nuclear energy and its limitations to compensate for the variability of renewable energies are regularly assessed *via* the analysis of scenarios, discussions with EDF and studies conducted using Mixoptim software developed by PG3 to optimize the response of a given electricity mix to a power demand. In parallel, research avenues capable of increasing the load-following dynamic for reactors are identified.





In the context of the CVT, PG3 also conducted a study on “Nuclear cogeneration: benefits and potentials of a low-temperature heat supply for French industry”. This study, currently shared with the main players in the sector, estimates the share of industrial heat requirements (less than 250°C) located less than 100 km from nuclear production sites and which could theoretically be supplied by cogeneration, to be 22 TWh.

With respect to topical issues, a number of meetings were organized (particularly with the IRSN) to discuss the challenges to be overcome in the fields of passive security systems, nuclear combustibles more resistant to accidents or new instrumentation requirements in pressurized water reactors.

Finally, ANCRE was consulted by the French Nuclear Safety Authority (ASN) in the context of its new mission to monitor and guide research in the field of nuclear safety and radiation protection. This initial contact will be extended by a joint ASN-PG3 project aimed at defining the potential contribution of ANCRE — expert assessments, research themes to be promoted, etc. — in these two fields.

▲ PG4 - Solar energy

Programmatic Group 4 aims to review the current situation for technological developments and identify research avenues in the thermal solar power (low temperature), concentrated solar power (medium to high temperatures) and photovoltaic solar power sectors. Two main actions are currently under way:

- ▶ a study on the technological and economic potential of high-efficiency photovoltaic technologies, being conducted within the CVT;
- ▶ the definition of research priorities in the field of concentrated solar power in the European context.

Launched in May 2016, the aim of the first study is to conduct a technical and economic assessment that can be used to analyze the potential of the three most mature principal technologies: crystalline silica, thin layers, and concentrated multi-junctions. This reflection process will be completed by the analysis of a fourth, more forward-looking technology, incorporating more efficient emerging concepts (perovskites, organics).



With respect to concentrated thermal solar energy, the CEA and the CNRS are jointly involved in a European project set to be launched in autumn 2016 (Integrating National Research Agendas on Solar Heat for Industrial Processes); this theme was also put forward as a priority for the 2017 ERA-NET call for proposals.

Another CEA-CNRS proposal relating to the production of electricity by a thermal solar power plant was developed in the context of the SET-Plan in close cooperation with the EERA-CSP* and ESTELA**. This proposal favors two options: Linear Fresnel concentrators with molten salt as the heat transfer fluid and pressurized air hybrid cycles for tower plants. Another seven options are also being discussed within the European working group, with the final selection (two to three configurations) expected to be made by the end of 2016 for submission to the European Commission.

*Concentrated Solar Power

**European Solar Thermal Electricity Association



▲ PG5 - Ocean, hydraulic and wind energy

Programmatic Group 5 focuses on:

- The launch of a study within ANCRE's Technology Transfer Consortium (CVT) concerning "Connection to the network and subsea connections of renewable ocean energy converters." An exhaustive state of the art, based on an extensive synopsis of the literature (publications, patents, etc.) is currently being analyzed. Coupled with a phase during which the views of industrial players will be heard in the 3rd quarter of 2016, this work will make it possible to qualify R&D or industrial development needs in this essential area of the energy transition.
- A more outward-looking European and global approach, with the proposal of several subjects concerning low-TRL renewable ocean energies to be supported in the context of the 2018-2020 program of H2020. To this end, a great deal of work was successfully carried out to find European partners capable of supporting these actions. In addition, to enhance France's capacity for national action in this field, an inventory of the current involvement of French players in international projects (particularly European) and PG5 representation within international bodies is currently under way.



▲ PG6 - Transport

The energy transition in road transport offers new R&I opportunities in the field of IC engines: development of software or technological solutions for engines with a high energy efficiency and low emissions, energy optimization of engines in real conditions, new engine-fuel pairings, etc. In addition, the energy vectors, electricity and hydrogen, which require the roll-out of dedicated distribution infrastructures, also pave the way for new fields of research for hybrid or electric powertrains. Along with technological changes, sustainable mobility opportunities can also be sought *via* changes in behavior, such as car-pooling, resulting from collaborative consumption practices.

It is for this reason that it appears to be pertinent to expand the traditional research approach focusing on transport system components — primarily versatile vehicles to reduce energy consumption — to a more global vision, taking into account the vehicle in its environment. The connective, cooperative vehicle — and, in the future, the self-driving vehicle — will require different infrastructures to travel, top up on energy or share information. Digital

technology plays a pivotal role *via* the deployment of services for fleet optimization, traffic management and operating assistance, which are also factors in obtaining energy savings.

This context has led Programmatic Group 6 to completely overhaul its methods in order to invest in a more systematic approach to transport, based on the vehicle-infrastructure-usages trio. In this context, the necessary links and relationships between these three components of the transport system will be examined, as illustrated by the “New energies, new services for mobilities” study conducted within the CVT, exploring the dedicated vehicle concept and proposing services for each specific usage for identified targets (companies, private individuals, public authorities, etc.).



▲ PG7 - Buildings

The objective of achieving reductions in greenhouse gas emissions and energy consumption in the construction and urban sector by 2030-2050 led Programmatic Group 7 to propose six strategic priorities concerning R&D efforts to be reinforced or developed on a national and international level:

- ▶ observation of real estate stock (critical points between the building envelope, equipment and networks), and representative usage and behavior scenarios;
- ▶ development and industrialization of technological solutions inter-operating within a systemic approach (buildings-district-city), in interaction with other sectors (electricity or heat distribution, mobility, etc.);
- ▶ development of simulation models that can be used to optimize the integration and interoperability of the various technologies, and multi-criteria decision aid tools aimed at construction industry players;
- ▶ development of multi-criteria economic analysis to support incentive policies and investors;
- ▶ development of training tools aimed at building trades;
- ▶ data management (density, flow, database, big data, etc.).

As part of the CVT, PG7 also carried out a study on the “H2020 building” aimed at objectively measuring the public and private R&D efforts of the sector. The results of this study have been the subject of numerous presentations, as illustrated, for example, by the symposium organized in liaison with the Fibres-Énergivie competitiveness cluster in Strasbourg on 22 October 2015 or, more recently, the symposium on “Key factors for success and innovation levers in construction”, organized in collaboration with the Tenerrdis competitiveness cluster and the CEA-INES at the latter’s site on 22 September 2016.



▲ PG8 - Industries and agriculture

In 2015-2016, Programmatic Group 8 introduced a new dynamic by organizing unifying events, identifying energy challenges in the main industrial sectors, introducing scientific and technological presentations at its meetings, and motivating new members from research centers and laboratories, industry and innovative institutes (ITE).

Thus, in the context of the CVT, PG8 defined and led the “Optisites” study focusing on the energy optimization of industrial sites and contributed to the PG3 study on nuclear cogeneration. More recently, PG8 led and launched a study concerning IT centers, making sure it was extended to take into account not only the area of waste heat recovery and recycling but also the energy optimization of electronic components and computer software. It is currently preparing two new strategic monitoring initiatives relating to energy recovery in the fields of industrial waste and solid recovered fuel; the objective is to construct an initial vision of these sectors, draw up a panorama of the industrial and academic players involved and develop a roadmap of priority R&I actions to be shared with industry.

Similarly, PG8 made a significant contribution to the “Heat in the energy transition” symposium on 21 January 2016, with several of its members speaking during the presentations, the round table and the final summing up session. It was also closely involved in the “Energy efficiency in industry” ecotechnological meeting jointly organized on 30 June 2016 by ANCRE, the “Eco-industry” sector strategic committee, the partnership for eco-enterprise excellence (PEXE) and the Carnot Institutes association. A symposium on agriculture and energy, to be organized jointly with ANCRE PG1 and the AllEnvi alliance is planned for 2017.

Finally, PG8 responded to numerous requests submitted to it by the public authorities, as illustrated, for example, by the expert assessment requested by MEP* Édouard Martin concerning the scientific and technological challenges to be overcome in order to maintain, in France and Europe, a sustainable basic metals industry in a green growth context.

*Member of European Parliament



▲ PG9 - Energy forecasting and economics

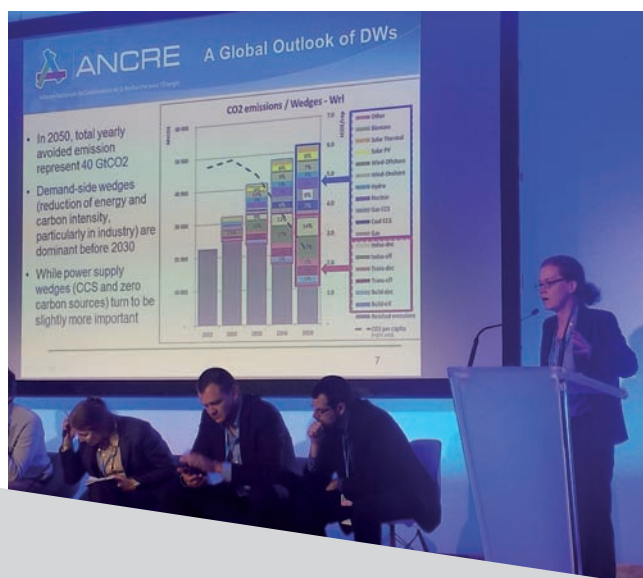
In 2015, Programmatic Group 9 coordinated a Decarbonization Wedges study on the levers for the decarbonization of the global energy system, published in December of the same year in the context of COP21. In 2016, it began a process to update work concerning

scenarios in France, the aim being to construct a pathway meeting the objectives of French energy transition for green growth legislation (LTECV). As part of this project, a new French energy system modeling tool — Opera — was produced to industrialize the scenario construction process.

PG9 is also committed to working with the Athena alliance in order to deepen our understanding of the human and social dimensions of the energy transition, and with the AllEnvi alliance to assess their environmental impacts.

In addition, within the CVT, PG9 initiated two studies designed to provide additional information.

The first, begun and completed in 2015, aimed to make a comparative analysis of the various “Energy initiatives” launched by major universities outside France (or involving them). The objective is to understand the factors for their success (in particular for studies involving academics and industrial players), with respect to research and training, and to make recommendations accordingly for a potential initiative of this type in France.





The second study — a joint project by PG9 and PG10 — was launched in the second half of 2016. It aims to analyze studies involving the modeling or simulation of an increasing and significant proportion of variable renewable energies in the electricity production system. The goals are, firstly, to identify the research that needs to be promoted in order to better understand and reduce uncertainties relating to the large-scale integration of these types of energy; and secondly, to qualify new technology needs, particularly for the management of networks, energy storage, and ensuring demand flexibility.

This research is regularly presented, shared and discussed with public authorities, academia and industry.

▲ PG10 - Energy networks and associated storage

With the support of the CVT, Programmatic Group 10 has developed a roadmap (available on the ANCRE website) entitled “What R&D needs to be conducted to develop the energy networks of the future?”. This roadmap takes

into account the new constraints facing energy networks: growing demand for electricity, growing share of renewable energies, occurrence of consumption peaks on the electricity network, increasing need for flexibility, impact of electric mobility, problem of storage, integration of smart technology in network management, etc.

This roadmap has been presented to the French Commission for Energy Regulation, the Systematic competitiveness cluster, the French Academy of Technologies and the CPU. Currently being reviewed as part of strategy and policy forecasting in liaison with the work of PG9, it will soon be expanded to take into account digital and ICT (information and communication technology) aspects, in close cooperation with the Allistene alliance.



THE THEME-BASED TECHNOLOGY TRANSFER CONSORTIUM SUCCESSFUL DEVELOPMENT

After an initial two years focusing exclusively on the production — at the initiative of ANCRE's Programmatic Groups — of strategic studies, the theme-based Technology Transfer Consortium (CVT) attached to ANCRE has gradually confirmed its position as a player in its own right in the national innovation ecosystem.



Key figures for ANCRE's CVT

▲ Completion of **9** strategic studies since 2013:

- ▶ thermal solar and concentrated thermal solar,
- ▶ energy optimization of industrial sites,
- ▶ organization of a biomass for energy supply chain,
- ▶ microalgal biomass for energy,
- ▶ H2020 buildings,
- ▶ sectors for deep underground energy recovery,
- ▶ benchmark of international initiatives in the field of energy,
- ▶ new energies, new services for mobility,
- ▶ low-temperature nuclear cogeneration for industry.

▲ Contribution to the organization of **13** symposia

▲ **50** requests for study reports

▲ **9** strategic studies currently ongoing

By matching academic research provision with the needs of industry, the CVT has promoted the development of a genuine community of interest in the field of strategic intelligence, as reflected, for example, by the increasingly significant investment of ANCRE's founding and associate members. Its work, which aims to identify opportunities and formulate recommendations *vis-à-vis* the sectors and technologies to be promoted, helps to develop links between ANCRE's scientific experts and technical and economic analysis experts in each of the areas studied.

Aimed primarily at ANCRE members, the CVT's strategic studies contribute to the development of Programmatic Group roadmaps, and also help inform the monitoring workshops organized within them. They are also the subject of broader dissemination on request, in particular to technology transfer players (SATT, IRT, ITE, Carnot institutes, competitive clusters, etc.), academic institutions and industrial players. This knowledge dissemination and transfer is carried out partly *via* the web interface set up by the CVT in 2015 (www.allianceenergie.fr/Les-Etudes-CVT.aspx), and primarily *via* the organization of symposia, usually organized jointly with competitiveness clusters in the field of energy, industry and innovative institutes (ITEs) or regional bodies (chambers of commerce and industry, etc.). This drive will be further stepped up in the coming years, with events such as the symposium organized jointly in January 2016 at the Ministry for National Education, Higher Education and Research with Programmatic Groups 3, 7, 8, 9 and 10, on heat in the energy transition.

One of the CVT's future development priorities will be the performance of studies for third parties, a move initiated with the study on "Industrial sectors for deep underground energy recovery".

In 2016, ANCRE's CVT was renewed for a further three-year period after a hearing by its supervisory authorities, during which a review of its activities was carried out. The objective and monitoring indicators, as defined in the ANR-CVT ANCRE agreement, were analyzed and a business plan for the coming years was submitted.

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French National Alliance for Energy Research Coordination

www.allianceenergie.fr