



2021-2022 ANNUAL REPORT

Cerema's scientific excellence for the benefit
of the French economy and its adaptation to
the effects of climate change



EDITORIALS

The Earth's climate is changing, and the diverse manifestations of this change are increasingly to the fore to remind us of it. Never before has humanity been confronted with the challenges of adapting to the effects of climate change on such a scale.

Unfortunately, the solutions – often very local – needed to adapt to these changes do not all already exist, far from it. Producing new insights, exploring uncharted fields and, accordingly, conducting research are therefore all-important.

This research activity is central to Cerema, as recently recalled in the research programming law and its implementing decree. For this purpose, Cerema is forging ever closer ties with the academic world by associating its teams within joint units.

The work carried out within our eleven teams brings new knowledge to Cerema experts and the socio-economic world via partnership research.

"Partnership research, which earned Cerema its "Institut Carnot Clim'adapt" labeling, is a founding element of our institution's strategic project to help businesses and local authorities adapt."

Indeed, helping to address the climate challenge and curb today's worrying trends is an urgent necessity that mobilises us on a daily basis.



Pascal Berteaud

Director General of Cerema

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"Cerema sounds the charge for a widespread mobilisation to help regions adapt to the changing climate: all our expertise is devoted to the climate and underpinned by our research activity, which produces precious knowledge for the partners of our Clim'adapt Carnot Institute, namely companies and local players."

Marie-Claude Jarrot

Chairperson of the Board of Directors of Cerema

The sixth report of the Intergovernmental Panel on Climate Change (IPCC) recently reminded us, if this were still necessary, how climate change – caused by human beings – requires us to act swiftly and strongly, both at an individual and collective level.

The six areas of activity in which Cerema is involved contribute to building cities and developing France's territory. These areas are ambivalent: while they represent significant levers for mitigating climate change to achieve carbon neutrality by 2050 (the target set by France's low carbon strategy), they also contribute to greenhouse gas emissions and suffer the resulting effects of climate change.

The rapid, far-reaching transformation required in terms of sobriety, efficiency and decarbonisation is taking place against a backdrop of climatic stress whose manifestations, whether sudden or through slow change, are already on an increasingly large and geographically diverse scale. Consequently, the hierarchy of issues involved in adapting to the effects of climate change faced by socio-economic players takes on a local dimension.

Thanks to the complementarity of its activities and the dense geographic mesh of its regional sites, Cerema can help companies and local authorities implement their transitions in a way that anticipates and accommodates this local dimension.

Being able to work with these two types of players is a strength for Cerema, as their respective problems go hand in hand. Surely, is not the challenge for any community, in a context of climate change, to perpetuate its economic health by developing its attractiveness and facilitating its (as carbon-free as possible) reindustrialisation?

"The challenges posed, reinforced by the legitimate quest for greater national sovereignty in certain sectors deemed strategic, give rise to new problems that naturally lead to partnership research actions, which lie at the heart of the Carnot system."

Furthermore, for Institut Carnot Clim'adapt, the period 2021-2022 was marked by a number of events and undertakings that helped to structure its development. We hope that you will enjoy discovering the happenings that we have selected to illustrate this annual report.

Thierry Braine-Bonnaire

Director of Institut Carnot Clim'adapt



CEREMA'S CLIM'ADAPT CARNOT INSTITUTE



Institut Carnot Clim'adapt operates under the aegis of **Cerema**, a public institution supervised by the French Ministry of Ecological Transition, and present throughout mainland France and the French Overseas Territories with its 26 sites and its 2,400 agents.

Benefiting from pooled national expertise, **Cerema supports the French State, local authorities and companies in implementing the ecological transition, adapting to climate change and ensuring territorial cohesion** through the cooperative development, deployment and assessment of public planning and transport policies.

With its considerable potential for innovation and research embodied by Institut Carnot Clim'adapt, Cerema is active in six areas of activity: Regional expertise and engineering, Building, Mobility, Transport infrastructure, Environment and risk, Sea and coast.

It has an annual budget of around €255 million.

CEREMA IN FIGURES:

26

sites in mainland and overseas France

2,400
agents

€255m
annual budget

For further information: [Cerema 2021 Annual Report](#)

In early 2021, Cerema restructured its service offering to support its public and private partners in their transitions more efficiently in the field. **Cerema is now positioned in six main areas of expertise, where the underlying objective is to help territories adapt to climate change.**

• **Regional expertise and engineering** to support town and country planning transition strategies

- Town and country planning strategy
- Knowledge and mobilisation of land



• **Building** to control the impact of buildings on the climate and improve their quality of use

- Real estate heritage management
- Environmental and energy performance
- Comfort and ventilation of buildings
- Geo- and bio-sourced materials
- Construction economics and legal frameworks
- Digital building
- Universal accessibility in buildings



• **Mobility** to promote sustainable and safe mobility

- Public spaces and urban roads
- Recognising, modelling and assessing mobility
- Mobility policies and services
- Intelligent transportation systems, traffic and regulation
- Road and travel safety



• **Transport infrastructure** to secure and sustain transport infrastructures, notably in the face of climate change

- Transport infrastructure asset management
- Transport infrastructure techniques, methods and monitoring
- Asset management for engineering structures
- Engineering structure techniques, methods and monitoring
- French national emergency bridge centre - CNPS





• **Environment and risk** to control natural risks and their impact on the environment, the climate and the consumption of resources used in development and transport projects



- Renewable energy sources
- Biodiversity and planning
- Water and the management of aquatic environments
- Circular economy of construction and civil engineering
- Natural risks
- Reducing pollution and planning

• **Sea and coast** to ensure the safety and sustainable development of marine and river activities by controlling their impacts on the environment, and adapting maritime and coastal areas to the changing climate



- Sea and coastal management
- Security and maritime and river traffic
- Ports and inland waterways



2021-2022 CEREMA HIGHLIGHTS



APRIL 2021

The institution's board of directors adopted a **new 2021-2023 strategic project** whose underlying objective is to help regions adapt to climate change. It initiates the strong mobilisation of Cerema's expertise for regions: as long as the climate changes, Cerema will be there!

<https://www.cerema.fr/fr/cerema/strategie>

OCTOBER 2021

The institution's first **2021-2024 objectives and performance contract** was adopted and signed by the French Minister of Ecological Transition. It is based on seven defining pillars, including the consolidation of the research activity.



MARCH 2022

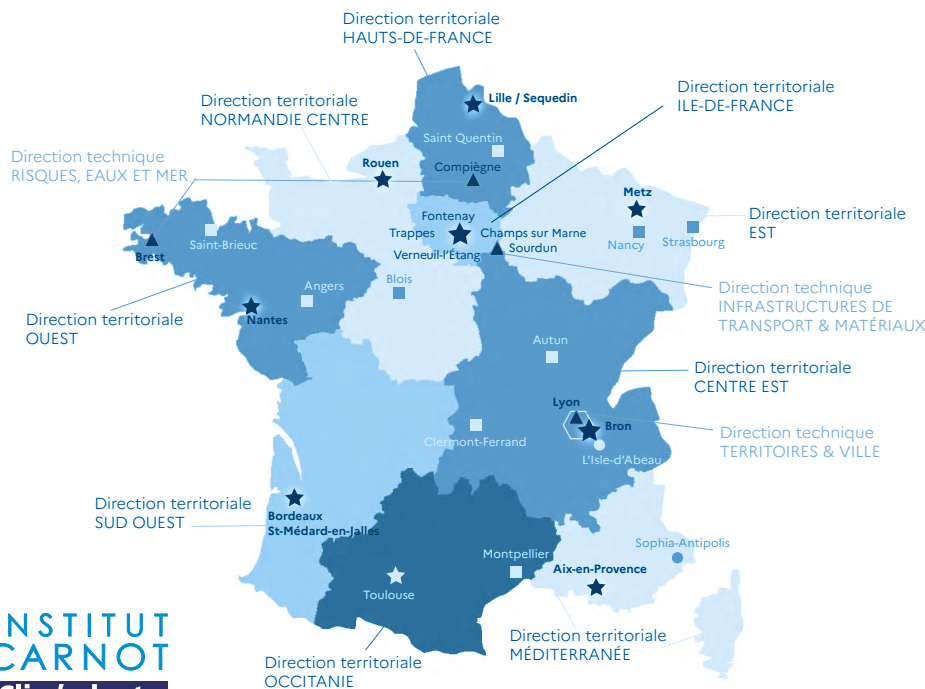
Cerema launched its **"Expertises.Territoires" cooperative platform**: a white-label network of experts.

This platform has a threefold aim: allowing players and decision-makers in the field to share experiences via a straightforward interface, and develop expertise in favour of the ecological transition throughout France; developing a cross-functional approach and strengthening ties between the professions and disciplines; questioning and clarifying the challenges of today and tomorrow.

<https://www.expertises-territoires.fr/>

MAP OF CEREMA SITES

labeled "Institut Carnot Clim'adapt"



DIRECTION TERRITORIALE	
★	Siège
■	Agence
●	Autre site
DIRECTION TECHNIQUE	
▲	Direction générale (Bron - Vaulx-en-Velin - Lyon)



EXPERT RESEARCH FOR THE BENEFIT OF REGIONS

CEREMA, A RECOGNISED PLAYER FOR RESEARCH IN FRANCE

In the summer of 2021, the publication of the decree establishing the list of the public institutions whose statutes provide for a research mission formally marked **Cerema's recognition as an organisation with research missions**. This new step confirms the scientific strategy endorsed by the strategic project, along with its objectives and performance contract, also adopted in 2021.

And so, for the first time Cerema will be assessed by the High Council for the assessment of research and higher education (*Haut Conseil de l'évaluation de la recherche et de l'enseignement supérieur* - Hcéres). This will take place in 2024-2025 along with the assessment of the objectives and performance contract, currently being drawn up.

SCIENTIFIC TEAMS INTEGRATED IN HIGHER EDUCATION

In 2021, the effort to structure the research teams, initiated since the creation of Cerema in 2014, will continue in each of the major fields in which the institution is scientifically involved.

The creation of joint research units (*Unités Mixtes de Recherche* - UMR) gained momentum in 2021-2022 with three objectives:

- fully integrating the teams into the French higher education and research system; the teams integrated in joint research units will themselves be assessed by Hcéres;
- improving the framework for hosting doctoral paths to make it even more attractive;
- allowing Cerema to assume full supervision of these joint research units.

AN ACTIVE DOCTORAL PROGRAMME

In 2021, 12 theses were defended and 25 directed or co-directed by at least one Cerema researcher, in collaboration with an academic team. Cerema currently accommodates 56 doctoral programmes within its teams.



DID YOU KNOW?

Five Cifre theses are in progress in 2022 at Cerema, with the following partners in the socio-economic sphere: Hydrasol, Seacure (formerly Geocorail), Routes de France, Spie Batignolles and Ingerop. Other industrial partnerships are involved in Cerema's doctoral programmes, including Clamens and Logiroad.

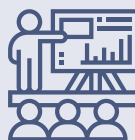


11

research groups

58

rank-A publications in 2021



39

communications during conferences in 2021

56

theses in progress

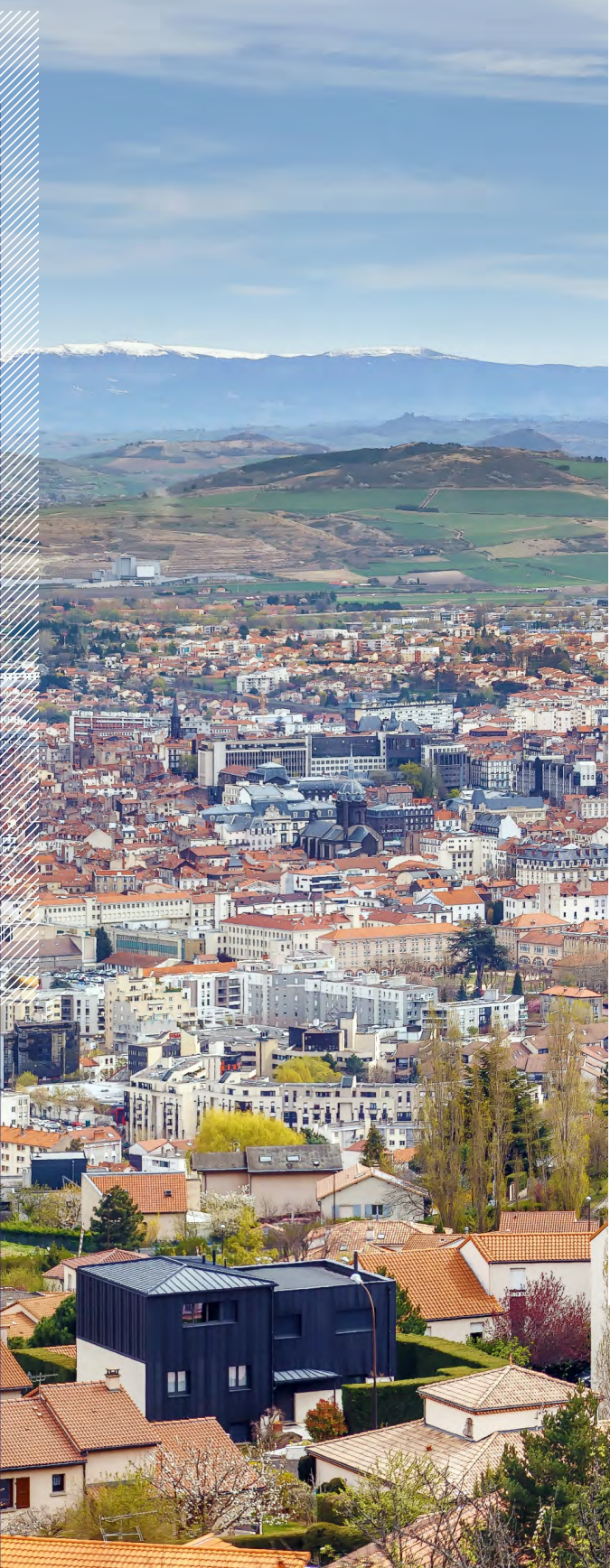


12

theses defended in 2021

Discover all our research groups





The REPSODY team (response of soils, sites and structures to dynamic loads–earthquakes and vibrations) integrated in a joint research unit.

On 6 December 2021, at the steering committee meeting organised by the Côte d'Azur University, the four supervisory bodies of UMR GéoAzur (*Université Côte d'Azur, Institut de recherche et du développement, Observatoire de la Côte d'Azur and Centre national de la recherche scientifique*) were in favour of integrating the REPSODY research team in this joint research unit, and of Cerema's entry in the team's governance as secondary scientific supervisory authority.

Cerema and the Gustave Eiffel University create a joint research unit dedicated to materials for sustainable construction.

On 28 February, 2022, Cerema's Durability, Innovation and valorisation of Alternative Materials (DIMA) team, along with the Formulation, Microstructure, Modelling and Durability of Construction Materials (FM2D) team from the Materials and Structures Department of Gustave Eiffel University decided to consolidate their partnership with the creation of a joint research unit, under the scientific supervision of the two institutions.

Dubbed "Materials for Sustainable Construction" ("*Matériaux pour une Construction Durable*" – MCD), this joint research unit focuses on the durability of construction materials for buildings and infrastructures in the fields of cement and bituminous materials. One of the objectives of this unit is to better incorporate these materials in the circular economy for the benefit of the environment. This undertaking strengthens the ties between Cerema and Gustave Eiffel University, as set out in the framework agreement signed in July 2021.

Cerema and Cergy Paris Université form a joint research unit dedicated to transport and mobility.

After the two parties had signed the framework agreement in December 2021, part of the Cergy Paris' MRTE team and Cerema's ESPRIM team joined forces to create a new joint research unit.

Dubbed "Mobilities, Planning, Transport, Risks and Society" ("*Mobilités, Aménagement, Transports, Risques et Société*" – MATRiS), and officially created on 1 January 2022, their scientific project focuses on the major transformation dynamics at play in transport and development systems, and the means with which to identify them, understand the complexity of their interactions, and model them.

See portraits
of researchers at Cerema



INSTITUT CARNOT CLIM'ADAPT

IN 2021-2022



INSTITUT CARNOT CLIM'ADAPT: OFFER AND MISSIONS

Cerema has been labeled "Institut Carnot Clim'adapt" since 2020. **This is the first time that the Institut Carnot labeling has been awarded to a project focused on climate change.**



DID YOU KNOW?

Institut Carnot Clim'adapt develops partnership research, i.e. research work carried out by public laboratories in partnership with socio-economic players, companies of all sizes, and local authorities, in response to their needs.

Institut Carnot Clim'adapt helps businesses and regional authorities to address the climate challenge and implement their transition towards a low-resource, low-carbon economy that respects the environment.

Through bilateral contract research services, Cerema provides these economic stakeholders with the scientific excellence of its researchers and experts, in the institution's six fields of activity:



These multidisciplinary, complementary areas of expertise enable Clim'adapt to develop solutions for adapting to climate change by incorporating the topic's systemic aspect and, accordingly, the resulting effects.

Institut Carnot Clim'adapt plays a key role as the **interface between companies and regional authorities** on the scientific and technical issues relating to economic development and land use management.

This represents a real opportunity to **deploy and test innovative solutions.**



"Faced with the challenges of adapting to climate change, Cerema pursues an active policy of research partnerships with companies in order to benefit from real-life experimental cases and promote technology transfer, from the research phase through to the marketing of the various solutions involved."

The institution provides companies with the specific expertise of its researchers and experts, both in France and internationally, as well as various tools and mechanisms, including CeremaLab, technological platforms, and the Expertises.Territoires collaborative platform, adapted to the needs of businesses, both large and small."

Anne-Laure Meunier

Director in charge of Cerema's business plan



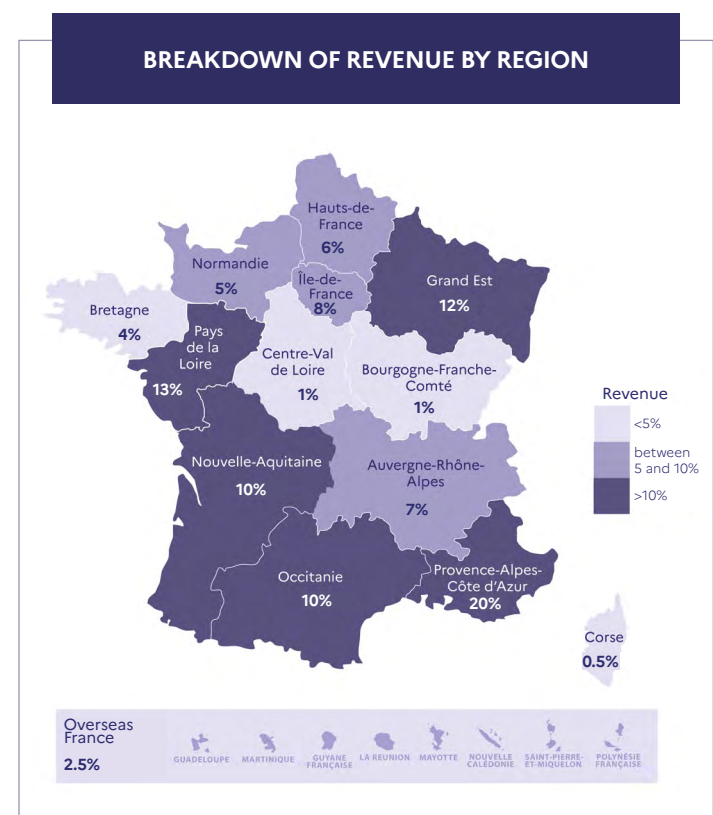
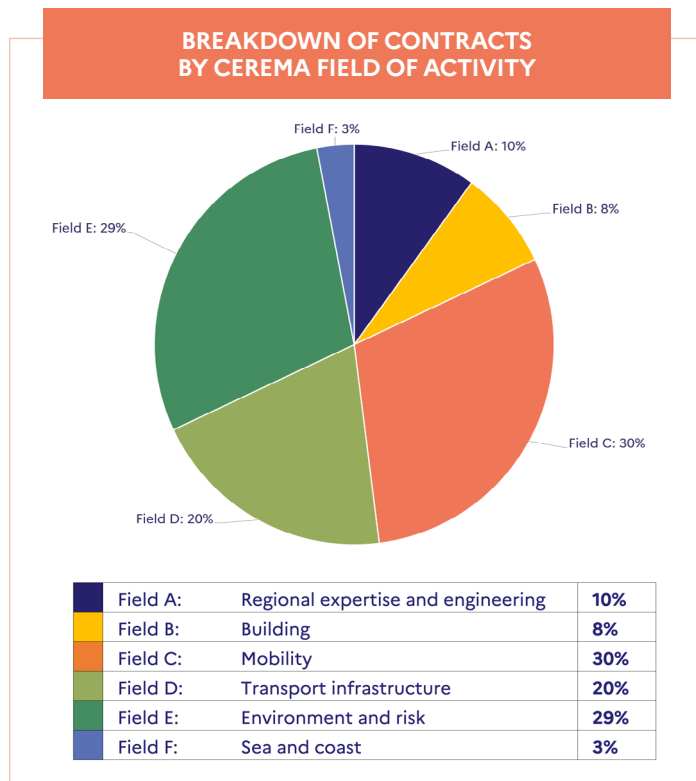
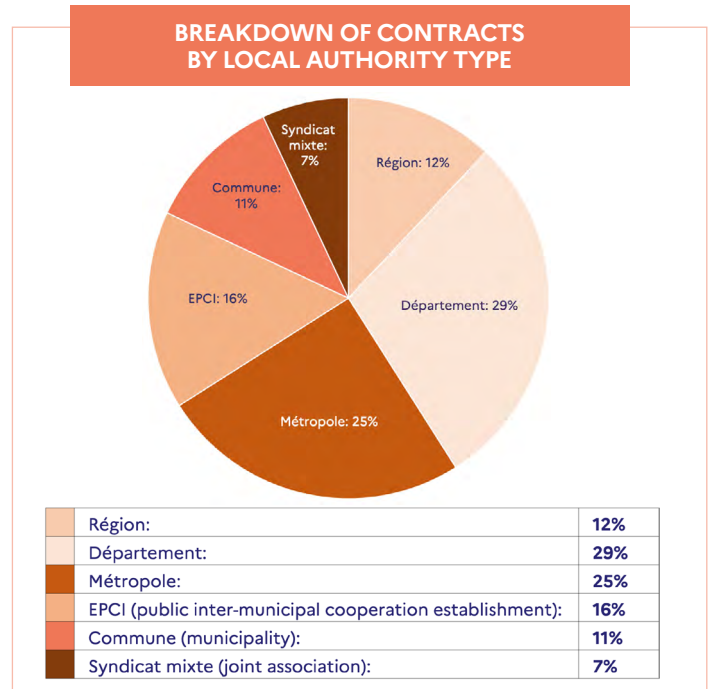
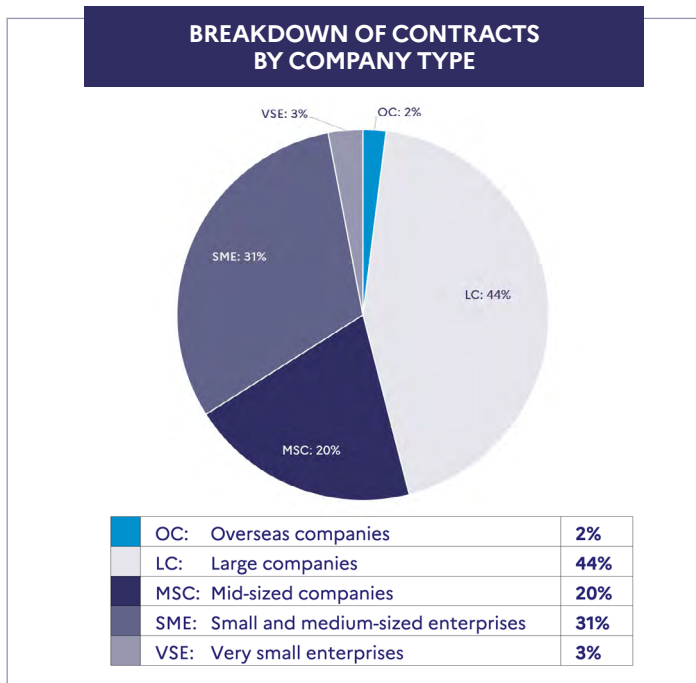
In this context, Clim'adapt has a threefold mission:

- **transfer Cerema's R&D to companies** to support them with their ecological transition and, in particular, their adaptation to climate change;
- **help companies to develop innovative, adapted solutions, characterise them in controlled conditions, and try them out in the field;**
- **support local authorities** to identify and implement solutions that match their needs **via partnership research.**

KEY FIGURES

In 2021, the combined revenues from Cerema's Carnot activity amounted to approximately €5 million. As illustrated in the charts below, this activity is highly diversified, both in terms of clients and areas of activity. It is developing throughout mainland and overseas France.

A partnership research activity that addresses all types of companies and authorities, whatever their nature and size.



An action for adapting to climate change implemented in all Cerema's fields of activity.

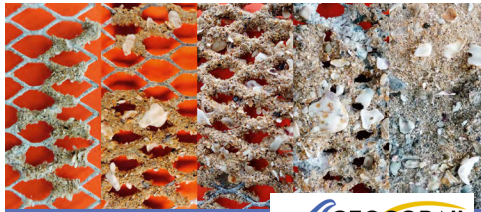
A very extensive regional coverage for partnership research that meets local specificities and issues, while ensuring that the results of this research can be effectively reproduced.

SOME EXAMPLES OF CARNOT CONTRACTS



Over this 2021-2022 period, Carnot signed numerous contracts for R&D services aimed at businesses and regional authorities. In fact, all those responsible for urban development, or who design, build and manage infrastructures are the natural partners of Institut Carnot Clim'adapt.

Here, in brief, are a few examples of successful partnerships.



PARTNERSHIP WITH GEOCORAIL



Design of a 2D and 3D digital model to describe the Geocorail process, and a sizing tool

Overview: The Geocorail process involves forming a rocky conglomerate in underwater environments thanks to an electrochemical reaction of seawater and the capture of sediments. Cerema's R&D work is based on the development of a modular electrochemical modelling tool used notably to size anode and cathode structures.



Sea & coast



PARTNERSHIP WITH COLAS



Development and testing of the Flowell device, a new dynamic light signage solution

Overview: Cerema is assisting Colas in the development and testing of its innovative Flowell product, which responds to the need for active luminous road marking, not provided for in the present regulations. Flowell serves to reinforce existing light-signalling systems, and to provide public spaces with greater modularity. A number of experiments are already under way; others are under review.

Transport infrastructure



PARTNERSHIP WITH ATMB



Assessment of car sharing measurement sensors at the Thônex-Vallard French-Swiss customs

Overview: The partnership between Cerema and ATMB concerns the performance assessment of sensors used in a system for counting the number of occupants in vehicles. These sensors will be the first building block in a system for automatically controlling a lane reserved for car sharing.

Mobility



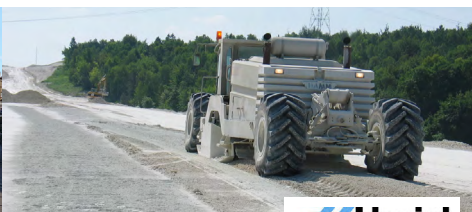
PARTNERSHIP WITH MÉTROPOLE ROUEN NORMANDIE



Development of a "bespoke" method for the complete diagnosis of the road network

Overview: At the request of Métropole Rouen Normandie, Cerema designed and developed a "bespoke" method for monitoring all of the metropolitan network's road assets, i.e. some 2,700 kilometres of roadways.

Transport infrastructure



PARTNERSHIP WITH LHOIST



The use of chalk treated with lime in hydraulic works

Overview: Cerema and Lhoist have undertaken a research project to determine the conditions in which chalk treated with lime can be used for the construction of dikes. While chalk is often used for road infrastructure, its behaviour under water is not well documented.

Sea & coast



PARTNERSHIP WITH APRR



A new solution for the diagnosis of external prestressing cables, i.e. sensitive components of large bridges made of prestressed concrete

Overview: In partnership with the Société des Autoroutes-Paris-Rhin-Rhône (APRR) motorway company, Cerema tested a new method for the magnetic inspection of external prestressing cables, i.e. the steel elements that ensure the stability of the structures retained by their tensioning. Using a non-destructive method, this diagnosis served to identify cables with defects due to corrosion.

Transport infrastructure



DID YOU KNOW?

Cerema works with start-ups. Its partnership with Geocorail (now Seacore) offers a perfect example of this partnership approach, in the scope of its CeremaLab facility (see page 19).



These projects concern very many areas, as illustrated in the following interactive image.



KEY EVENTS

IN 2021-2022

In 2021-2022, Institut Carnot Clim'adapt presented Cerema's offer at a number of events. The Clim'adapt team also organised and took part in various events, as illustrated by the frieze below:

1 July 2021

INTERNAL WEBINAR

"Understanding the Carnot label and its advantages for Cerema"

16 December 2021

Launch of the call for scientific resourcing projects by Institut Carnot Clim'adapt (FY 2022)

25 November 2021

2nd Clim'adapt Strategic Direction Committee (SDC) meeting

DEC.



17-18 November 2021

LES RENDEZ-VOUS CARNOT

SEPT.

21-22 September 2021

INNOPOLES EXPO PARIS



NOV.

16-18 November 2021

LE SALON DES MAIRES ET DES COLLECTIVITÉS LOCALES

28 September 2021

CAP'CARNOT

OCT.



12-15 October 2021

POLLUTEC



1 April 2022

First meeting of the year of Carnot Institut quality managers



APR.

23 March 2022

TECHINNOV

7 April 2022

Carnot directors' seminar



JUNE

22-23 March 2022

Meeting of the Carnot network's communication officers, and training on internal communication

20-21 June 2022

CEREMA RESEARCH DAYS

(see double page overleaf)

MAR.



FEB.

17 February 2022

First meeting of the Carnot strategic communication group, of which Clim'adapt is a part

22-23 June 2022

CARNOT SEMINAR

3 February 2022

OCCITANIE INNOV

Encounters for innovation in Occitania

FEEDBACK ON CEREMA'S RESEARCH DAYS

On 20-21 June 2022, at the NewCap Event Center in Paris, the first Cerema Research Days event took place. Animated by Stéphanie Lux, this event's underlying theme was: "What research for tomorrow's climate and regions?".

Indeed, climate change brings France and its economy face to face with challenges of an unprecedented nature and scope. The stakes for French regions and economic players are considerable. How can Cerema help local authorities and businesses in their transition to a low-resource, low-carbon economy that respects the environment?

The researchers, experts and partners of Cerema and, more generally, **all the respected players involved in the scientific and socio-economic spheres were able to discuss these matters, and many others, illustrated by specific cases.** They also sought to prove that, together, they could help to meet these challenges.

A FIRST DAY DEDICATED TO REGIONAL ACTION RESEARCH

This day kicked off with a video address by Pascal Berteaud, Director General of Cerema, followed by a speech from Pascal Terrasse, Strategy and Communications Director.

On the agenda:

- a round table entitled "What action research for the ecological transition of France's regions?" with speakers from Cerema as well as from the CNRS (National Centre for Scientific Research), France Ville Durable, Efficacy and the ADEME (French environment and energy management agency);
- a talk by Julien Guerrier – Director General of the European Commission's Common Policy Centre – on the subject of the Missions undertaken by the R&I Horizon Europe framework programme;
- a round table discussion on "Mobilising research and expertise for the resilience of the regions: the merit of building scientific partnerships with Cerema", with talks by five pairs of Cerema researchers and scientific partners (INRAE, Inria, Côte d'Azur University, Gustave Eiffel University and CY Cergy Paris University);
- a round table discussion entitled "What scientific assessment for research focused on the needs of regions?" with the participation of Cerema, IGN, MESRI and IFPEN.

The day was brought to a close by Ronan Dantec, French Senator of the Loire-Atlantique department, and President of the environment commission of the French Association of European Municipalities and Regions (AFCCRE).

A SECOND DAY DEDICATED TO CEREMA'S PARTNERSHIP RESEARCH, BACKED BY ITS CLIM'ADAPT CARNOT INSTITUTE

The day began with an introduction by Thierry Braine-Bonnaire, Director of Institut Carnot Clim'adapt.

On the morning's agenda:

- a sequence entitled "Cerema faced with scientific, economic and industrial challenges", comprising three talks:
 1. "The ecological transition: what scientific and industrial challenges?" by Yves Bréchet, Scientific Director of Saint-Gobain, member of the French Academy of Sciences;
 2. "The ecological transition: an opportunity to reindustrialise France", by Frédéric Motte, President of *Mission Rev3* and Regional Councillor of the Hauts-de-France region, responsible for the economic transformation;
 3. "Efficient use of data: a source of sobriety for the French economy", by Thierry Chambon, Director of Strategy and Partnerships for Energisme and Loamics;
- a round table with three speakers and Thierry Braine-Bonnaire.

The afternoon was dedicated to capitalising on partnerships between Clim'adapt, represented by Cerema researchers and experts, and companies: Colas, Engie Green, Lhoist, Covéa, Predict Services and EDF. There was also a sequence on CeremaLab, i.e. Cerema's platform for innovative start-ups and SMEs (see page 19). The partnerships with Seacure (formerly Geocorail), InSitu Architecture and TechnoCarbon were also presented.

This second day came to a close with a conference by Jean Jouzel, climatologist, member of the French Academy of Sciences, and Chairman of the Strategic Direction Committee (SDC) of Institut Carnot Clim'adapt.

In addition, participants were able to see an exhibition of 21 scientific posters created for the event, underscoring the value of the projects undertaken by Cerema's research teams. During these poster sessions, Cerema researchers were present to talk with participants and answer their questions.

The Cerema Research Days brought together a hundred or so participants on each day, with a further hundred unique visitors in streaming mode on 20 June. All in all this first edition proved to be a great success.

"With a staff of 35, Predict Services wishes to remain a small, operational and highly agile structure. Despite Cerema's size and clout, we were pleased to find a very considerable degree of agility and responsiveness in our mode of operation with Frédéric Pons.



By engaging a great deal of very practical and operational discussion on an extremely virtuous subject with considerable expectations, this public-private partnership has given us the capacity to move forward very very quickly. I am very grateful to Cerema for this collaboration which I hope will bring lots of good things in the years to come."

Alix Roumagnac

President of Predict Services

"Throughout my career, I believed that mitigation took priority over adaptation. My wife and I had a bet that people would only really wake up once global warming became noticeable, in around 2030, not before. That was my belief 30 or 40 years ago. It is clear that the extreme events we are now seeing mean that people's perception of global warming is already a reality.

This necessarily goes hand in hand with the imperative need to consider adaptation on an equal footing with mitigation."

Jean Jouzel

Climatologist, member of the French Academy of Sciences and Chairman of the Strategic Direction Committee of Institut Carnot Clim'adapt



To learn more and discover a photo gallery, other verbatim comments and all of the scientific posters on display at the exhibition



SCIENTIFIC RESOURCING

Scientific resourcing is one of the three uses of the funding received by Cerema's Carnot Institute, Clim'adapt; the other two are professional development, and integration in the Carnot system.

This resourcing is intended to maintain the establishment's scientific excellence, accredited by the Carnot labeling, and anticipate the demands of markets and industry. The scientific resourcing actions may concern research projects or project for acquiring strategic equipment, as was the case this year.

CALL FOR PROJECTS 2022

FOUR WINNERS SELECTED

At the end of 2021, Institut Carnot Clim'adapt issued an internal call for scientific resourcing projects. The eight applications received were assessed by the Clim'adapt team and the members of the SDC, based on a grid containing various criteria: contribution of the project to Institut Carnot's revenue, compliance with the purpose of Clim'adapt, potential for generating new research contracts with other companies, etc. The ranking of the applications was presented to the Clim'adapt steering committee and validated.

UPDATE ON THE PROGRESS OF THREE PROJECTS RETAINED IN 2021

MACH+

In France, the latest census established by the Ministry of Ecological Transition at the end of June 2021 reported more than 10.4million houses at a potentially high risk of clay shrinkage and swelling. Cerema, Institut Carnot Clim'adapt, is currently developing the MACH+ solution based on Artificial Intelligence (AI) to enable buildings exposed to drought and the effects of climate change to adapt. Both innovative and ecological, the MACH+ solution is used to predict, based on

local meteorological data, when the foundation soil needs to be automatically rehydrated, during periods of drought, using rainwater previously collected and stored to re-balance its water status. An experiment on the scale of a test house is under way and will continue up until 2025.



DID YOU KNOW?

Research projects are carried out with other Carnot institutes, such as MADNESS (monitoring and decision support for the predictive maintenance of roadways) with Carnot ARTS and the ROAD-AI challenge with Inria.

The share of the funding received by Institut Carnot Clim'adapt and allocated to scientific resourcing for the financial year served to **select and financially support the following the four items of equipment:**

CAISSON FOR HYDRAULIC TESTING OF WORKS

Overview: The envisaged device will serve to experiment, on a scale of 1, with the failure mechanisms of diking systems (internal and external erosion, overflow discharge, etc.) for different configurations of works (in terms of slopes, materials, densities, permeability, compaction, formulations, etc.) and for different hydraulic conditions (permanent, transitory, cyclical, etc.).



Cerema research team involved: HA

IMPEDANCE ANALYZER

Overview: The requested equipment is used to characterise the dielectric permittivity of materials at low frequency to better interpret the results of assessments by geophysical radar. This is particularly important with new geomaterials about which little is known in terms of their characteristics, or the changes in these characteristics under the effects of climate change.



Cerema research team involved: ENDSUM

DEVICE FOR MEASURING THE HYDRODYNAMIC PROPERTIES OF SOILS AND ROCKS

Overview: This device will serve to highlight the hydrodynamic properties of soil (water retention curve and hydraulic conductivity curve) and, accordingly, the development of high-level digital models that take into account the characteristics of unsaturated soils.



Cerema research teams involved: GéoCoD, TEAM, UMR MCD

DJI DRONE AND IR CAMERA

Overview: The M300 RTK drone and the Wiris thermal camera are used to inspect soils, areas with a complex topography (cliffs, landslides, etc.) and works (walls, dikes, bridges, etc.) with highly precise positioning, both inside and outside built-up areas.



Cerema research team involved: ENDSUM

JeunEpi

For the needs of the JeunEpi project, the Xbeach, SWAN, TELEMAC, IH2VOF and OpenFOAM software solutions were installed and their performance investigated. This served to define the recommendations for using each solution.

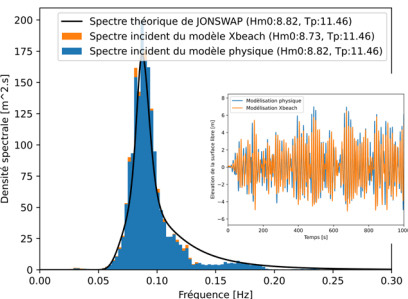
EcoNav

The EcoNav project comprises three phases:

- extending the fuel consumption model to all boats on the Seine;
- extending the Kessel module to the entire length of the Seine;
- combining the two.

The instrumentation of five units is planned as part of the "Eco Pilote Seine" project, financed by ADEME. Consumption measurements will serve to extend the consumption prediction model using machine learning to other representative units.

To test "Kessel", the Andrésy reach and its traffic were modelled for three months based on AIS data. We obtained an average reduction in the waiting time at the lock of 6 minutes per boat, and a 13% reduction in the water used. An experiment in Andrésy will specify the actual performance levels. Developments for modelling several locks are starting.



Initial comparisons of statistical and spectral parameters were carried out with available in-channel experimental results. The correct digital parameters, the appropriate boundary conditions and the method for processing the results have been stabilised. As a result, we can now envisage a context for the operational use of these tools. No optimisation of the results will be sought to obtain the results of the physical model. The digital modelling campaign has been planned and is set to be launched. The physical tests campaign began in July 2022.



COMMITMENT FOR COMPANIES

With its Institut Carnot Clim'adapt certification, Cerema delivers services for private companies to the value of €12 million, or one third of the establishment's own revenues (source: [Cerema's 2021-2023 strategic project](#)).

Within its six fields of activity, it represents a national, unbiased guarantor via its work for supporting regulations and standardisations, making recommendations, proposing good practices and, where applicable, labelling and certification.

Cerema also acts as a complementary partner to private companies to better meet often complex local, national and international needs. Its expertise is sought within consortia in response to calls for projects and tenders, particular in terms of innovation, given the establishment's specific know-how. Cerema also increasingly supports French companies overseas with a view to promoting and disseminating French expertise.

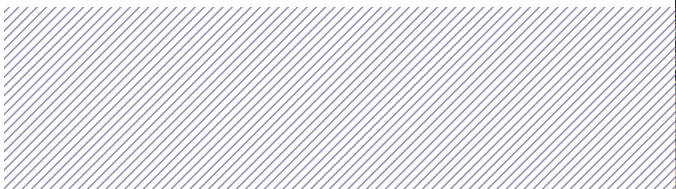
Via Institut Carnot Clim'adapt, Cerema consolidates its partnership research activities geared towards the socio-economic world. Clim'adapt effectively transmits Cerema's research and innovation to companies of all sizes – start-ups, SMEs, large corporations, and construction industry majors who are the establishment's historic partners.

Industrial players turn to Cerema from different perspectives. In fact, with its impact on the climate and, more generally, the environment, industry acts on two levels:

- the production process is often a large consumer of non-renewable resources, while emitting greenhouse gases and other effluents;
- the products manufactured, once implemented, can play a positive role in terms of attenuation and adaptation; accordingly, industrial investments increasingly favour these products.

Thanks to Cerema's diverse expertise and the regional coverage of its sites, it can interact with industrial companies on both levels: reducing the former, and increasing the latter.

Moreover, like any other human activity, industrial activity may also be under threat from climate change. Here too, Cerema's expertise proves to be precious.



CEREMALAB, ONE YEAR OF ACTIONS FOR THE BENEFIT OF INNOVATIVE STARTUPS AND SMEs



Initiated in October 2020, CeremaLab is a mechanism dedicated to innovative SMEs and start-ups that develop products and services related to Cerema's areas of activity. This mechanism is intended to accelerate their projects and increase their impact on France's regions.

CeremaLab fits in with Clim'adapt's objective of stepping up interactions for bilateral partnership research with small companies.



CeremaLab is part of the Greentech Innovation network of incubators, overseen by the French Ministry of Ecological Transition.

In 2021, CeremaLab carried out numerous actions intended to identify – and forge ties with – businesses that develop innovative solutions. Throughout the year, CeremaLab built up its image as an organisation that listens to start-ups. Businesses were able to enter into contact with CeremaLab through various trade events or webinars (Rencontre Ecotech Territoires, Meet'Up Greentech, Innopolis Expo Paris, Pollutec, Rendez-vous Carnot, among others). As a result, CeremaLab met more than 40 businesses, before guiding them towards the appropriate internal contacts to assess the possibilities of backing their projects.

Ten support agreements have been signed, for example In Situ, U.R.B.S. and BMT. By providing its expertise, its technological platforms and its research, development and experimentation capacities to innovative start-ups and SMEs, Cerema is committed to the future, as close as possible to regional projects throughout mainland and overseas France.

The CeremaLab ecosystem now comprises **more than 60 businesses.**



2021-2022 CEREMALAB HIGHLIGHTS

SECOND HALF OF 2021

Organised with the Grand Est Region and the Grand E-Nov+ regional innovation and international prospecting agency, in partnership with the *Pôle Véhicule du Futur* and *Fibres-Energivie* competitiveness clusters, **CeremaLab's second call for projects served to identify regional companies offering innovative solutions in the fields of building and mobility.** Out of 28 applications, the jury selected four winners: High Cube Eco Habitat, Les Constructeurs du Bois, Urbanloop and Urban Radar.



It also awarded a "coup de cœur" (favourite) award to TESC Innovation.



OCTOBER 2021

Cerema consolidated its presence in the innovation ecosystem by signing a cooperation agreement with Bpifrance aimed at mobilising their respective resources and skills to further support for deep-tech start-ups engaged in disruptive innovation for the fight against climate change and its effects.



FIRST HALF OF 2022

The call for projects "Innovation: maritime traffic from sea to port" by Cerema and Shom, co-organised in the scope of CeremaLab and the Shom lab, in partnership with ENSM, GICAN, les Pôles Mer, Port Atlantique La Rochelle and the Port of Marseille Fos, proved to be a great success, with 31 projects submitted. Nine finalists were selected to pitch before a panel of judges, who selected four winners: Sea Proven, Zelin, UAVIA, and Amphitrite.



D-ICE Engineering also won a "coup de cœur" (favourite) award.



To learn more about CeremaLab



INSTITUT CARNOT CLIM'ADAPT

MEMBER OF THE CARNOT NETWORK



THE CARNOT LABEL

Created in 2006, the Carnot label is intended to develop **partnership research**, i.e. research work carried out by public laboratories in partnership with socio-economic players, mainly companies (from SMEs to large groups), in response to their needs. Representing an important lever for the economy, partnership research encourages business innovation, which in turn fosters competitiveness and growth.

The Carnot label is awarded to **public research structures, "Carnot institutes"**, that carry out upstream research activities to renew their scientific and technological skills in parallel with a proactive policy of partnership research for the benefit of the socio-economic world.

The ministry in charge of research grants the label to Carnot institutes following a highly selective call for tenders.

The Carnot institutes provide a broad range of skills in response to the R&I needs of companies in most business sectors. In order to draw on their complementarities and leverage synergies for the benefit of their economic partners, they are organised as **an operational network spearheaded by AiCarnot**.

By keeping in permanent contact with companies, they can understand and **anticipate R&I responses for the various sectors** via pro-active scientific resourcing focused on the need.

The Carnot institutes adopt an approach to continuously improve **the professionalism of their partnership relations**. This approach extends from the first contact to the negotiation and set-up of the project, the supply of deliverables and the gathering of feedback.



DID YOU KNOW?

Carnot institutes like Clim'adapt are public research structures, labeled by the French ministry in charge of research, and committed to developing and conducting their partnership research activity in favour of the innovation of companies – from SMEs to major groups – and socio-economic players. The Carnot system is managed by the French National Research Agency (ANR).



For further information:

www.instituts-carnot.eu/en/carnot-label

KEY FIGURES

39

Carnot institutes organised as a network

20%

of staff from the public research sphere

55%

of R&D financed by French public research companies

10,000

Carnot-company contracts signed each year

Target for R&D sales of

€1 billion

with companies in 2030



"It is during times of crisis that innovation is strongest. Representing a unique alliance of 35,000 R&D professionals driven by the same passion for science and technology in response to society's major challenges, the Carnot network is, more than ever, an ally of choice for companies that develop the solutions of tomorrow."

Jean-Denis Muller

Director General of AiCarnot

CEREMA'S QUALITY APPROACH

Cerema's "Coesion" quality system is intended to guarantee the quality of its productions. It serves to monitor and assess the goals of the strategic project and of the objectives and performance contract. Continuous improvement represents a basic principle of the quality approach, in addition to monitoring the context, listening to the environment and managing risks and opportunities.

For the 5,000 projects undertaken each year, including those within the scope of Carnot Clim'adapt's activities, the initial specifications serve as the basis for evaluating the quality of each project. The quality of the projects is also monitored via customer satisfaction assessments: 99% are satisfied overall with Cerema's productions*.

In 2021, the institution obtained the NF EN ISO 9001 and Qualiopi certifications for training. The quality of its production rests on the quality of its tests and measurements; 30% of them are conducted under Cofrac NF EN ISO 17 025 certification.

Cerema's activity is carried out in the scope of a socially responsible approach that is part of the Coesion quality system.



DID YOU KNOW?

Carnot quality managers meet once or twice a year to share their experiences and good practices. These meetings are an opportunity to discuss the latest audits (internal, external or carried out in conjunction with Carnot), exchange ideas with specific experts and open up to related issues such as social responsibility.

*Source: Customer satisfaction assessment on production.
Synthesis from September 2021 to March 2022.

THE "CLUB EUROPE" OF CARNOT INSTITUTES



Cerema is an active member of the *Club Europe des instituts Carnot* and of its core facilitation team. Comprising some 150 members, the club's goal is to increase Carnot's revenues and support its industrial partners in Europe. It operates as a dynamic network for exchanging information and documents, organises several annual thematic meetings on current topics, and deploys a dedicated documentary platform hosted by Cerema.

In 2021, the focus was placed the new "Horizon Europe" programme to facilitate the positioning of members in French or European bodies, as well as to provide access to detailed information for as many players as possible before calls for projects, all with a view to increasing our response and success rates. More specifically, on May 19, 2021 the club organised a training session on optimally drafting the "Impact" aspects in submissions to Horizon Europe calls for projects. With more than a hundred participants, this session was very much appreciated by members.

CEREMA'S SCIENTIFIC EXCELLENCE FOR THE BENEFIT OF THE FRENCH ECONOMY AND ITS ADAPTATION TO THE EFFECTS OF CLIMATE CHANGE

BILATERAL CONTRACT RESEARCH FOR:



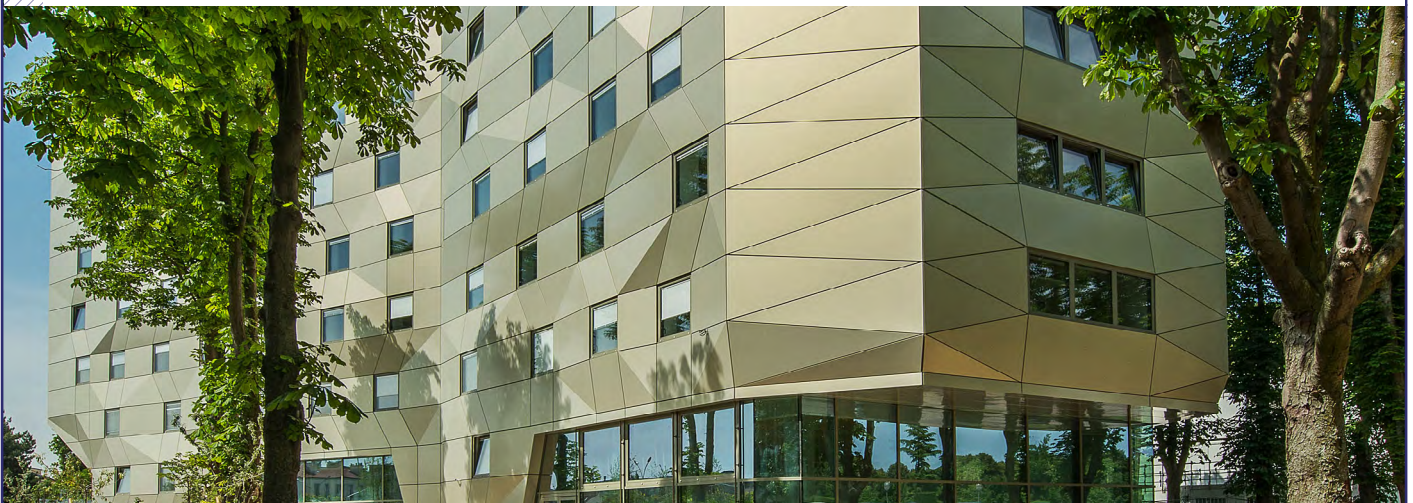
LOCAL AUTHORITIES

From municipalities to regions



BUSINESSES

From startups to multinationals



CLIMATE CHANGE: ADAPTATION TO ITS EFFECTS, ATTENUATING ITS CAUSES

Circular economy

TRANSITION

Sobriety

FULL-SCALE TESTING

NATURE IN CITIES

Acceptability

Biodiversity

Building, neighbourhood, town and networks

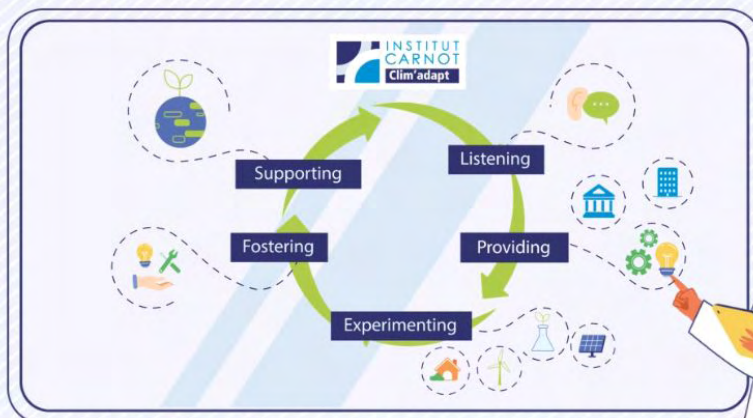
Performance and durability

Natural hazards

Urban hydrology

Prototype

RESILIENCE



Understanding the activity of Cerema's
Clim'adapt Carnot Institute in video and
in less than 2 minutes



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Graphics: Cerema - August 2022

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Do you have any questions or needs? Would you like to work with us?

By all means share your scientific challenges with us, we will be delighted to examine them with you.

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