

ROAD

DART TO LOOK
TOWARDS

A worker wearing a blue jacket, white helmet, and yellow gloves is working on a large green industrial pipe. The pipe is part of a complex system with various valves and fittings. The worker is holding a yellow tool, possibly a wrench or a screwdriver, and is focused on the task. The background shows a large industrial facility with a high ceiling and various pieces of equipment. The text "DARE TO LOOK TOWARDS THE FUTURE AND INNOVATE IN THE PRESENT" is overlaid on the image in white capital letters.

**DARE TO LOOK TOWARDS THE FUTURE
AND INNOVATE IN THE PRESENT**



THE WORLD'S MOST ADVANCED ENERGY GROUP R&D DIVISION

Thanks to the expertise of its researchers, its testing facilities and its digital capabilities, EDF's R&D division is in a position to prepare for the future and open up possibilities in the world of energy.

EDF's R&D division services the requirements of all business lines and activities in the energy sector.

It directs its research in line with the Cap 2030 project, serving the EDF Group's raison d'être.



Every day, EDF R&D's researchers work alongside people in all of the Group's job functions, improving their operational and technical performance, and so preparing for its future.

Bernard Salha, EDF Group Technical Director,
EDF R&D Director



EDF's raison d'être

Build a carbon-neutral energy future that combines global preservation, well-being and development, through electricity and innovative solutions and services.



R&D'S AIMS

Every day, R&D supports the EDF Group's business lines and subsidiaries in three ways:



Improving the EDF Group's performance

in all of its current ventures and enabling its customers to benefit.



Preparing for the energy scenarios of the future

by working on disruptive solutions and technologies.



Carrying out research for commissioning bodies outside the group

within the framework of partnerships or orders.



Would you like to know more about the support that EDF's R&D activities can provide you? **Download the solutions catalogue** by scanning this QR code.



Did you know? R&D also shares its knowledge and expertise by getting EDF's researchers to deliver training through the ITECH training body.

Find out what training programmes are available by scanning this QR code



THE STRENGTHS THE R&D DIVISION

- The expertise of women and men driving performance across the energy sector, consolidated by 75 years of research
- Our computer codes and digital simulation systems
- Our physical laboratories and models
- Our network of partnerships



R&D IN FIGURES



1 780 employees in France
and **225** employees abroad



160 PhD students



45 nationalities represented



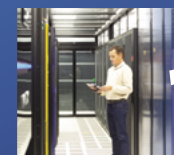
9 centres in France and abroad and a delegation in Brussels



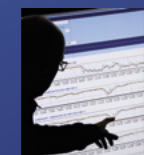
2 158 patents in France and abroad



More than **70** testing, measurement and simulation platforms



11 petaflops of computing capacity



More than **300** academic and industrial partnerships



20 joint laboratories



€487 million budget in 2021 for EDF's R&D division (EDF SA)

1/3 of which is used for forecasting and paving the way for the Group's future



99% of the R&D division's operating budgets in France dedicated to decarbonising and enabling the transition of energy systems

2/3 of which is used to support the performance of the Group's various business lines

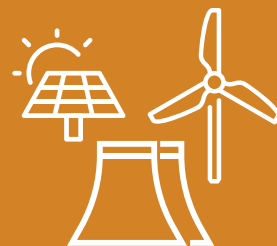


OUR SCIENTIFIC PRIORITIES



Area 1

Decarbonising
our customers'
uses with
electricity



Area 2

Strengthen
the performance
of generation
assets



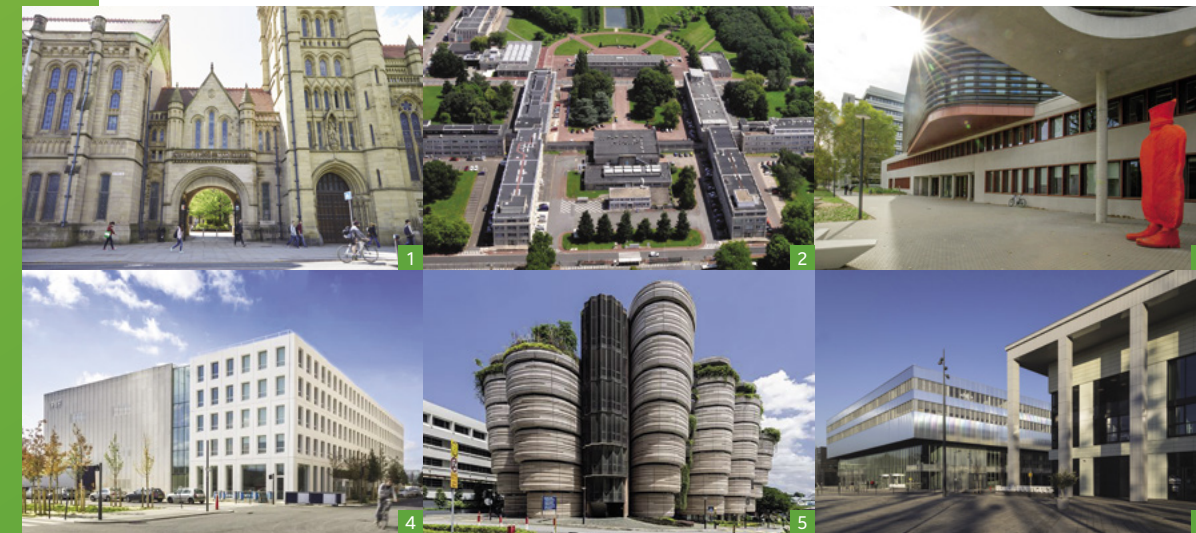
Area 3

Inventing
the energy
systems of
tomorrow



Area 4

Accelerate
the digital
transformation



PARTNERSHIPS

A NETWORK OF STRONG ALLIANCES BETWEEN ACADEMIA AND INDUSTRY

To meet business needs and find solutions to major research challenges, **R&D has built a network of more than 300 partnerships in France and at international level** with universities, research institutes and academic and industrial partners.

Among the most prestigious international partners are the Massachusetts Institute of Technology and the EPRI in the US, the Karlsruhe Institute of Technology in Germany, the University of Manchester in the UK, the University of Xian Jiaotong in China, Nanyang Technological University in Singapore, and Politecnico di Torino and Politecnico di Milano in Italy.

20 joint laboratories

R&D has set up for several years now, about twenty laboratories that have been working together with academic partners and technical or industrial centres, and have participated in collaborative research projects with them, financed by various national or European funds.

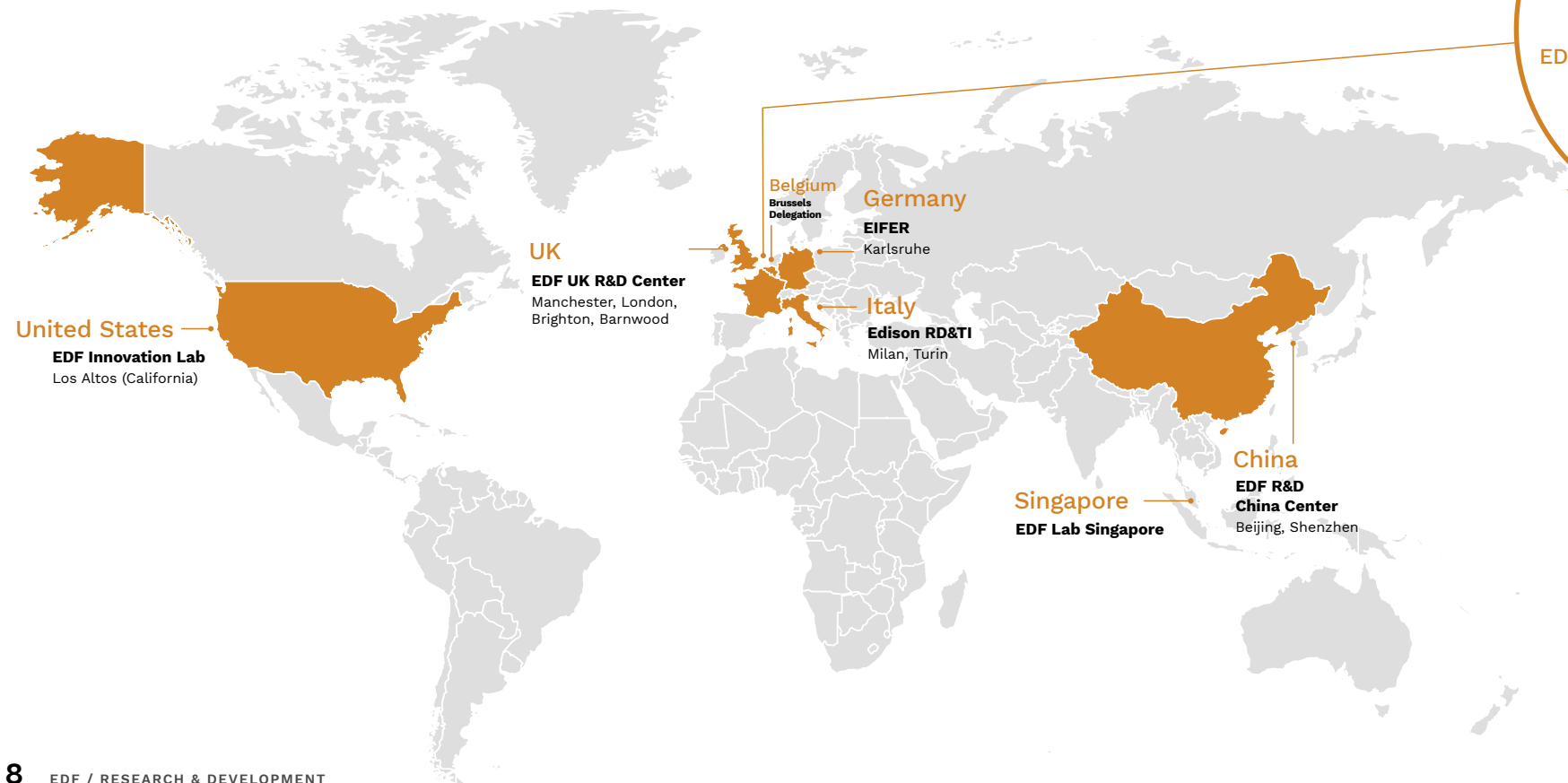
Each joint laboratory is an opportunity for a mixed team to focus on developing a solution to one shared scientific and technical problem, with the aim of generating value, and developing knowledge and expertise for all partners.

There are many joint laboratory agreements. Here are two examples: research conducted with the IPVF in the field of solar photovoltaic energy. Also research into artificial intelligence with Total and Thales at the Sinclair laboratory.



R&D INTEGRATED WITH THE WORLD

With **3 centres in France** and **6 abroad**, plus a delegation in Brussels, EDF conducts research both nationally and at international level.

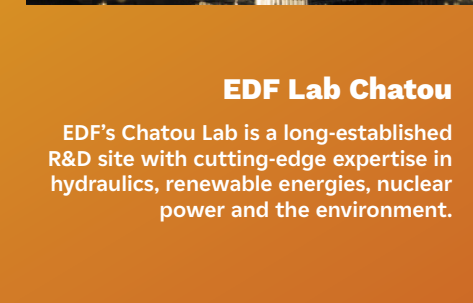


THE 3 PARIS REGION SITES



EDF Lab Paris-Saclay

Since 2016, the Paris-Saclay EDF Lab has been located right in the heart of a world-renowned scientific ecosystem - the Saclay research centre - which will eventually host 20% of all French research.



EDF Lab Chatou

EDF's Chatou Lab is a long-established R&D site with cutting-edge expertise in hydraulics, renewable energies, nuclear power and the environment.



EDF Lab les Renardières

EDF's Renardières Lab is the Group's largest R&D site. It is home to some of the world's most high-performance test facilities.

OUR INTERNATIONAL SITES

Located in areas where innovative technologies and business models thrive, our international centres coordinate or support **key projects** for the Group.

EDF R&D delegation in BRUSSELS

The Brussels delegation represents the EDF Group's R&D activities in its dealings with European institutions. Its remit is to facilitate the creation of collaborative projects, provide access to sources of funding, seek partners and help to draft project documents.



ITALY [Milan, Turin] Edison RD&T

Main research areas:

- Smart homes and IoT
- Advanced photovoltaics
- Power-to-X and hydrogen
- Electrical mobility
- Storage

GERMANY [Karlsruhe] EIFER

Main research areas:

- Climate neutral territories
- Local multi-energy systems
- Low-carbon hydrogen solutions
- Energy transition, markets and environment



UK [Manchester, London, Brighton, Barnwood] EDF UK R&D Center

Main research areas:

- Nuclear: modelling and simulation; Natural and environmental risks; Waste and decommissioning
- Offshore wind
- Energy systems, flexibility and storage
- Low-carbon mobility
- Integrated energy hubs and low-carbon hydrogen
- Smart digital technologies: Data science, IA and Blockchain

CHINA [Beijing, Shenzhen] EDF R&D China Center

Main research areas:

- Nuclear
- Renewable Energies, Storage & Advanced Cycles
- Decentralised energy systems
- Low-carbon urban energy planning
- Advanced electrical systems
- Electrical mobility
- Digital innovation
- Artificial intelligence



SINGAPORE EDF Lab Singapore

Main research areas:

- Urban and energy planning
- Microgrids & energy management systems
- Electrical mobility
- Software development

UNITED STATES [Los Altos/California] EDF Innovation Lab

Main research areas:

- Evolution of energy markets to accommodate a renewable mix
- Distributed energy resources and their integration into the distribution network
- Electrical mobility
- Use of blockchain and quantum computing
- Analysis of technological and market trends



WORLD-CLASS EXPERTISE, TESTING FACILITIES AND KNOWLEDGE

The R&D division draws on its energy experts, using them to help find solutions to the problems facing the entities and subsidiaries making up the EDF group and its external clients.

To do this, it is able to make use of 70 of the world's most modern and high-performance testing, measuring and simulation platforms operating in all areas of the energy sector.

Here are just some of EDF's R&D laboratories and testing facilities.

EDF Lab Paris-Saclay

Test Hall → 17 m high with a floor area of 700 m², the test hall houses a complete set of testing facilities used for industrial research in electrical-technical areas and structural mechanics. ¹

ConnexLab → Dedicated to digital innovation for the nuclear sector (augmented reality, virtual reality, chatbots, digital twins, artificial intelligence), this laboratory is used to develop models and prototypes for the design, operation and maintenance of nuclear power plants. ²

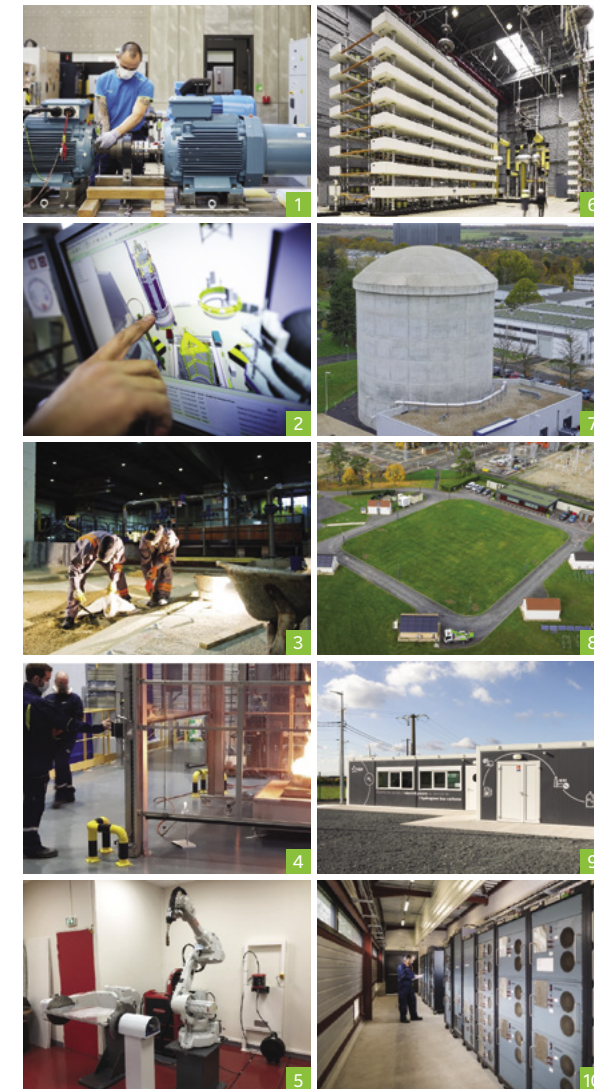
The digital instrumentation and control platform → The R&D division uses its expertise, methods and tools to develop a range of digital instrumentation and control engineering solutions to cover everything from needs analysis right up to the design of a complete plant. To do this, it has an instrumentation and control test platform located at the EDF Lab Paris-Saclay site which plays a key role in equipment qualification testing and integration.

EDF Lab Chatou

Hall J → This 10,000 m² testing hall houses equipment and resources for the physical modelling of hydraulic flows and sedimentary transport. Since 1947, it has been minimising the impact that electricity generating plants have on the aquatic environment, and protecting it from damage (floods, storms, etc.) ³

IGNIS → This full-scale facility investigates fires that can occur at nuclear facilities. Its purpose is to provide a better understanding of fire risks and their consequences on plants. ⁴

The WAAM welding laboratory → The WAAM (Wire Arc Additive Manufacturing) is an additive manufacturing or 3D printing process, which involves manufacturing or repairing major components using a welding robot and a wire. Its purpose is to enable better control of our manufacturing processes. ⁵



EDF Lab les Renardières

High-Power Testing Station → This station tests the resilience of electrical equipment to strong currents and provides tools for investigating the tripping capabilities of protective devices. ⁶

VERCORS (VERification Réaliste du Confinement des Réacteurs) → A 1/3 scale model representing a double-wall enclosure, which studies the accelerated behaviour of the enclosure's concrete and structure, as well as changes in leak rates. This physical enclosure model has a digital twin. ⁷

Concept Grid → This test facility has resources for testing innovative equipment and "smart" solutions for distribution networks. It anticipates and supports changes in electricity systems, by offering full-scale tests. Its remit is to develop new smart electricity systems for tomorrow's grids by integrating renewable energies and new uses of electricity. ⁸

The electrolyser test platform → Responsible for supporting the EDF Group, in particular its Hymanics subsidiary, over the entire hydrogen production and use chain, this facility tests and qualifies technologies for mature electrolysers. It assesses the impact of supplying electrolysers with variable electricity from renewable energy plants. ⁹

Battery cell and module testing centre → This centre conducts studies and assessments of everything from electrochemical cells to complete packages focusing on: detection and testing of next-generation prototype batteries, testing batteries for commercial use and research into their second life. ¹⁰

The electron microscopy laboratory → This laboratory has five electron microscopes for characterising and analysing materials down to the atomic level: two transmission microscopes for everything from undertaking chemical to microstructure analysis via high-resolution imaging, and three scanning electron microscopes, which provide advanced functionality for ion beam machining, maintaining controlled atmospheres and micro-mechanics for in situ measurements.

The Energy loop → This test facility reproduces fouling on the secondary side of steam generators subjected to the same kinds of two-phase flows as pressurised water nuclear power plants. This loop has recently been adapted so that other phenomena – such as the clogging of steam generator struts in two-phase environments – can be studied.

EXCEPTIONAL DIGITAL SIMULATION FACILITIES

As a leading player in this area, the R&D division shares its expertise in major digital simulation software and supercomputers with its clients.

In 2021, EDF's R&D division acquired more than **11 petaflops** of computing power with the GAIA supercomputers and the latest CRONOS.



CRONOS

Computing resources for science needs are pooled, so the new CRONOS supercomputer is shared between the R&D division (45%), the New Nuclear Engineering and Projects division (25%) and FRAMATOME (30%). This way, it can meet the intensive digital simulation requirements for studies.

In 2021, CRONOS ranked **67th on the list of the world's 500 most powerful computers**, and was the eighth most powerful computer in France!

CONNEXITY: THE DIGITAL INNOVATION PROGRAMME

In June 2017, industrial partners working with the French nuclear sector joined forces to create an ambitious R&D work programme, the aim being to integrate major innovations into the design and implementation of facilities for controlling and preparing nuclear power plant sites.

The ConnexiTy programme was built based on an industrial sector approach and involves implementing numerous highly leveraged concept demonstrators with the aim of bringing players together, thus simplifying the operation and design of nuclear power plants: designers and operators, operations and maintenance players, EDF and its industrial partners.



EDF R&D computer codes: two examples



For more than 30 years, code_aster has been a modelling tool used in mechanics. It simulates the resilience and mechanical behaviour of structures, such as nuclear power plants and hydroelectric dams.

Its distinctive feature is its ability to take into account - in simulations - complex physical phenomena (cracking, thermal, irradiation, etc.), which are sometimes unique to nuclear engineering and therefore not provided for in commercial software.

Developed by EDF's R&D division, code_aster can also be used to industrialise mechanical research work, and thus make it available, by deploying the software, to various EDF group engineering projects.



Risk-BU is decision-support software for managing risks related to energy markets: electricity, gas, coal, CO₂ quotas, oil products, etc.

It secures portfolios of production assets and supply contracts.



INNOVATIVE R&D TO PREPARE FOR THE FUTURE

→ AGRI PV

An innovation for use at solar power facilities: leveraging the complementary nature of traditional farming activities and solar power plants.



→ OFFSHORE WIND

The R&D division is supporting EDF Renewables as the offshore floating wind farm sector becomes more developed. Amongst other things, it is providing its modelling expertise.



→ SMR

The R&D division is continuing its research on the NUWARD SMR, the result of a consortium between EDF, CEA, Technicatome and Naval Group. It supports the Nuclear new builds division, simplifying the architecture and integrating passive safety systems.



→ BIODIVERSITY

The R&D division has implemented an ambitious programme to support the EDF Group and protect biodiversity (fauna and flora) in the areas surrounding its generating plants.

→ CHARGING STATIONS

The R&D division works on bolstering the reliability and durability of charging stations deployed by the Group's entities (IZI, IZIVIA, DREEV), by testing and qualifying equipment.



→ STORAGE

The R&D division is fully committed to EDF's storage plan. It investigates the lifespan, performance and second life of batteries.



→ LITE DERMS

An affordable and scalable microgrid management solution for speeding up access to electricity throughout the world.



→ INTERACTIVE IMMERSIVE PLANT

The R&D division has a virtual reality simulator for training field staff so they can work on nuclear power plants.



→ RESPONSE

A European H2020 project of the EDF group, led by EIFER, which aims to promote "positive energy neighbourhoods", with Dijon as the pilot city in France.



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[#EDFLab](https://twitter.com/EDFLab)

The R&D division is hiring



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