

ROAD

The word "ROAD" is rendered in a large, bold, white sans-serif font. The letters are cut out, revealing a blurred background of a road with a yellow pole or signpost. The background is dark and out of focus, suggesting a night or low-light setting.

**DARE TO LOOK
TOWARDS**

The words "DARE TO LOOK" and "TOWARDS" are rendered in a large, bold, white sans-serif font, stacked vertically. The letters are cut out, revealing a blurred background of a road with a yellow pole or signpost. The background is dark and out of focus, suggesting a night or low-light setting.

A worker in a blue uniform and white helmet is working on a large industrial machine with green pipes in a factory setting. The worker is holding a yellow tool. The machine has several large green pipes and a yellow cable. The background shows a large industrial building with a staircase and various equipment.

**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 R&D division is in a position to prepare for the future and open up possibilities in the world of energy.

EDF R&D division services the requirements of all business lines and activities in the energy sector. The research conducted is aligned with the EDF Group's strategy to serve its *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 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.



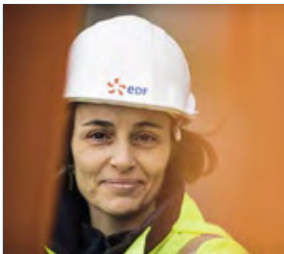


THE STRENGTHS OF THE R&D DIVISION

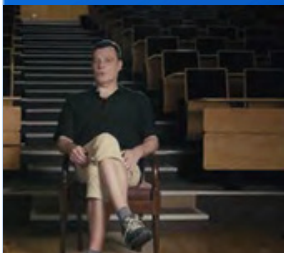
- The expertise of women and men driving performance across the energy sector, consolidated by 75 years of research
- Our computer codes and digital simulation systems
- Our physical laboratories and models
- Our network of partnerships



R&D IN FIGURES



1 830
employees in France



More than
250
academic researchers



Expertise of
women and
men of EDF
R&D



49
nationalities



220
experts and senior researchers with
a high level of expertise on a national
and international scale

31% of
women



16% under
the age of 30



298
employees outside France



160
PhD students

Opening up to a group with

180 000
employees worldwide

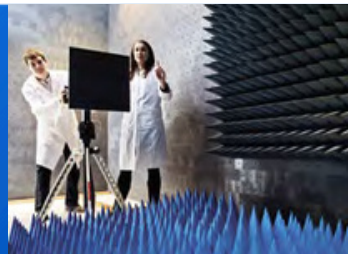


More than
300
academic and industrial
partnership



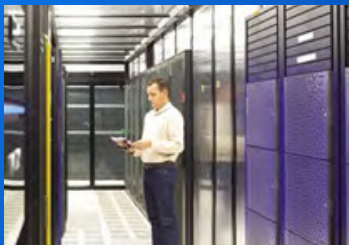
Outstanding testing facilities

9 research centers in France and abroad



More than 70 testing, measurement and simulation platforms

11 petaflops of computing capacity



21 joint laboratories

532 M€ budget in 2023

100% of operating budgets dedicated to decarbonization and energy systems transition

19.5 M€ from service sales or grants



Energy decarbonisation facilities





Concrete results

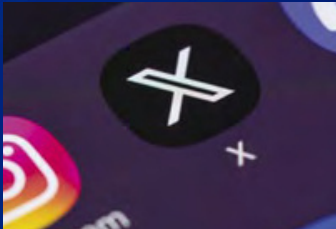
400

R&D projects
conducted in 2023



2 170

patents



5 million views
on X

45

initiatives with
schools/ universities
(forum and school
visits)

300

scientific publications in
peer review journals in 2023

R&D IN FIGURES



OUR SCIENTIFIC PRIORITIES



Area 1

Decarbonising
our customers'
uses with
electricity



Area 2

Strengthen
the performance
of generation assets



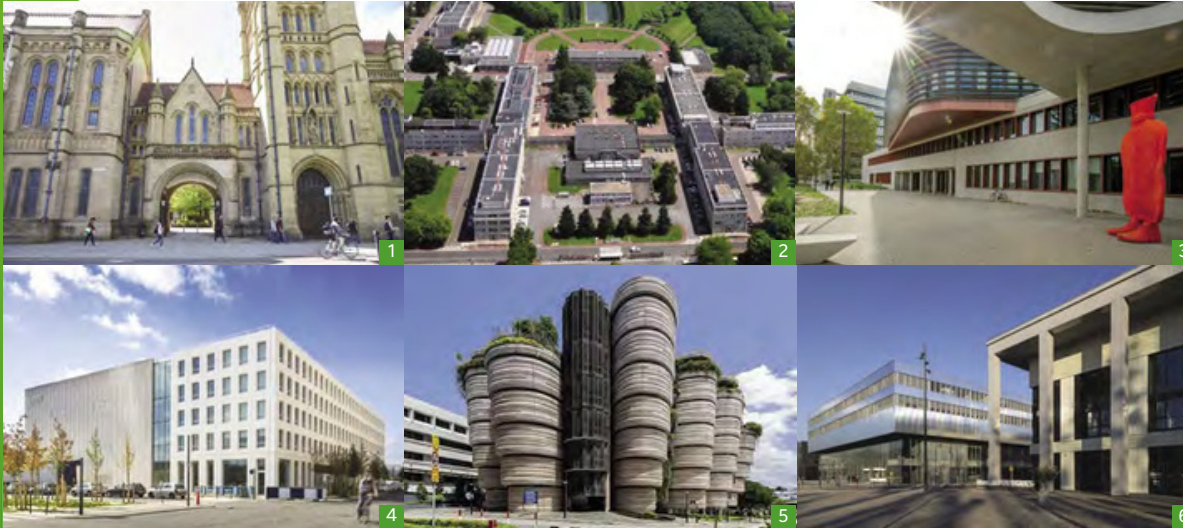
Area 3

Inventing
the energy
systems of tomorrow



Area 4

Accelerate
the digital
transformation



21 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 TotalEnergies and Thales at the Sinclair laboratory.

PARTNERSHIPS

A NETWORK OF STRONG ALLIANCES BETWEEN ACADEMIA AND INDUSTRY

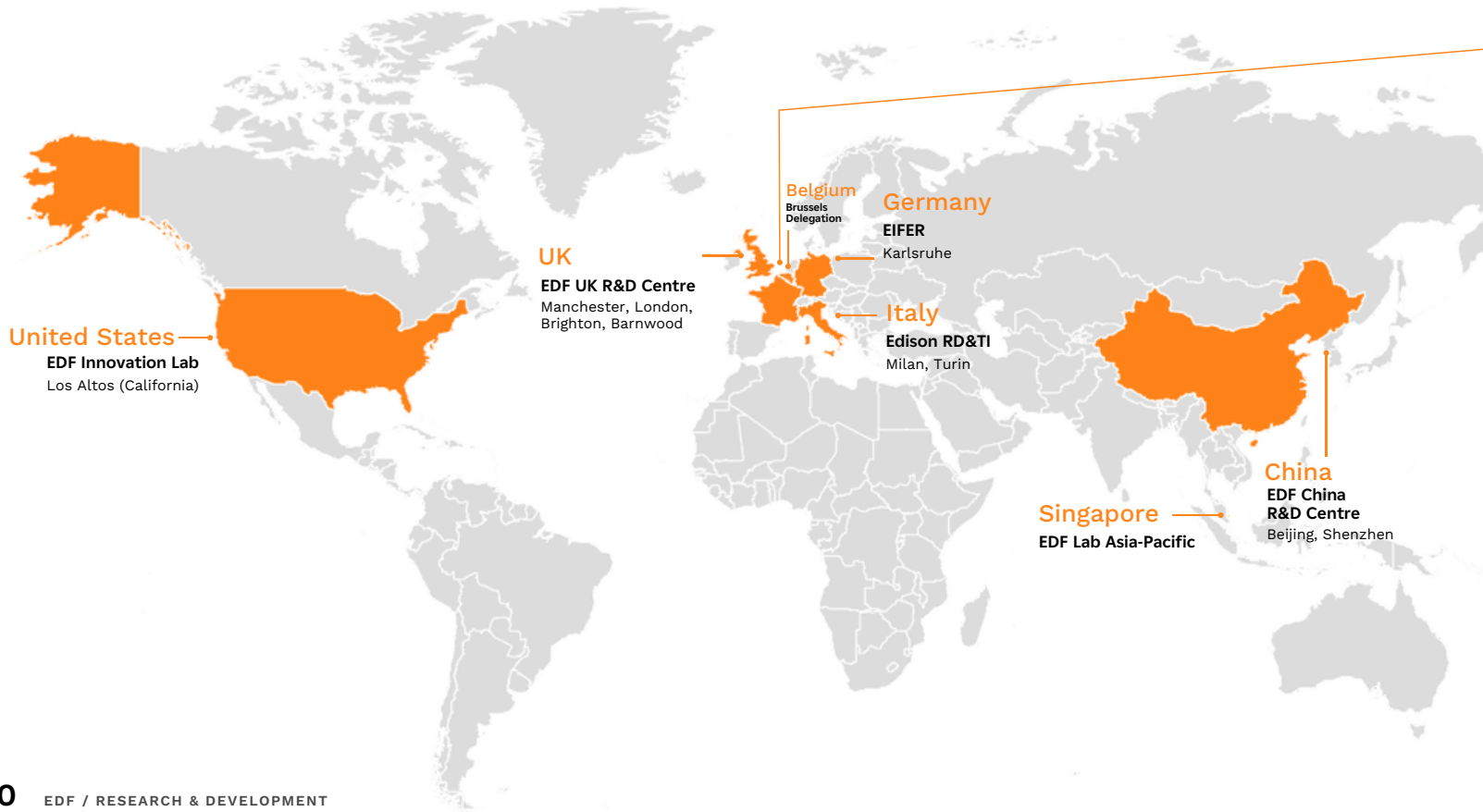
To meet business needs and find solutions to major research challenges, R&D has built a **network of more than 300 partnerships in France and at international level** with universities, research institutes and academic and industrial partners.

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.

1 University of Manchester, UK 2 French alternative energies and atomic energy commission (CEA), Paris-Saclay 3 Karlsruhe Institute of Technology (KIT)
4 Ile-de-France solar panel institute (IPVF) 5 Nanyang Technological University (NTU) 6 CentraleSupélec, Paris-Saclay.

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.



REGION 3 PARIS



EDF Lab Paris-Saclay

Since 2016, the EDF Lab Paris Saclay has been located right in the heart of a world renowned scientific ecosystem. Paris Saclay research centre will ultimately host 20% of 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 testing 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.



GERMANY [Karlsruhe]

EIFER

Main areas of research:

- Climate neutral Communities
- Local multi-energy systems
- Low-carbon Hydrogen Systems
- Energy transition, markets and environment

ITALY [Milan, Turin]

Edison RD&TI

Main areas of research:

- Smart Home & IoT
- Robotics
- Advanced Photovoltaics
- Electric Mobility
- Hydrogen & Decarbonation
- Smart cities



UK [Manchester, London, Brighton, Gloucester]

EDF UK R&D

Main areas of research:

- Nuclear
- Natural Hazards and Climate Change
- Offshore wind
- Energy systems, flexibility and storage
- Low-carbon mobility and heat
- Integrated energy hubs and low-carbon hydrogen
- Data science and artificial intelligence

EDF R&D delegation in BRUSSELS

The Brussels delegation represents the R&D within the European Affairs division of EDF and in the interface with European Institutions. Its missions are to bring the EDF Group scientific messages and knowledge towards the EU institutions, to facilitate the emergence of collaborative projects at the EU scale, to help EDF R&D teams access European funding and to connect with the most influential partners in the EU.

CHINA [Beijing, Hangzhou] EDF China R&D Centre

Main areas of research:

- Nuclear
- Renewable energy, hydrogen, storage and advanced cycles
- Decentralised energy systems
- Advanced electrical systems
- Electric mobility
- Decarbonization
- Digital Innovation
- Artificial intelligence



ASIA-PACIFIC [Singapore] EDF Lab Asia-Pacific

Main areas of research:

- Interconnections & smartgrids
- Land & Maritime electric mobility
- Low Carbon Hydrogen
- Renewable energies
- Energy markets
- Quantum Computing

UNITED STATES [Los Altos - California] EDF Innovation Lab

Main areas of research:

- Smart Grids
- Electric mobility
- Energy markets
- Customer Solutions
- Digital technology
- Net-Zero Carbon Solutions
- Open Innovation
- Nexalis





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 →

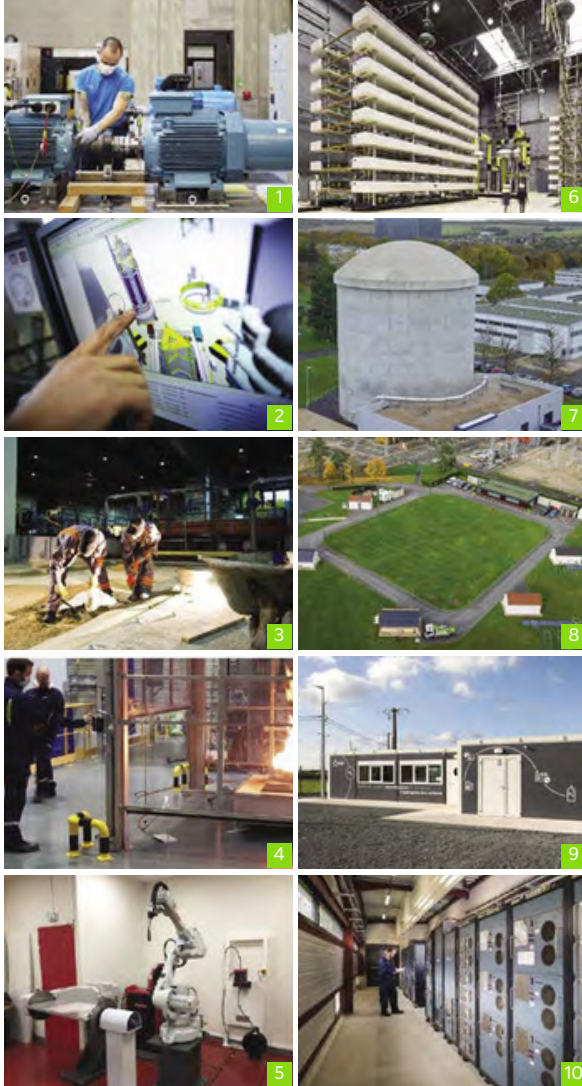
The R&D division uses its expertise, methods and tools to develop a range of digital instrumentation and control engineering solutions to cover everything from needs analysis right up to the design of a complete plant. To do this, it has an instrumentation and control test platform located at the EDF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

EDF Lab Chatou

Hall → 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 RéacteursS) → 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 Hydnamics 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.

EDF / RESEARCH & DEVELOPMENT



In 2021, EDF 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 ConnexlTy 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.),



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.



which are sometimes unique to nuclear engineering and therefore not provided for in commercial software.

Developed by EDF 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.





INNOVATIVE R&D TO PREPARE FOR THE FUTURE

→ AGRI PV

An innovation in line with the EDF Group's renewable energy development ambitions, combining farming activity with 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.



NEW REACTORS

R&D is continuing its research on the NUWARD SMR, the result of a consortium between EDF, CEA, Technicatome and Naval Group. It is also monitoring various AMR concepts, 4th generation reactors, and is provide its expertise to an ecosystem of start-ups.



→ BIODIVERSIT Y

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.

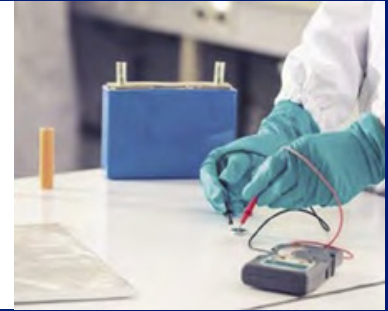
→ CHARGING STATIONS

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

R&D is fully committed to developing electrical storage technologies. It investigates the lifespan, performance and second life of batteries.



→ CONTINUED OPERATION OF THE PLANT

R&D is working to improve knowledge and control of equipment ageing in supporting of the nuclear fleet management teams.



→ INTERACTIVE IMMERSIVE PLANT

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

→ POSEIDON

A European project led by Eifer, paving the way for the production and use of synthetic methanol (e-methanol) as a fuel in maritime transport. A driving force behind the elimination of fossil fuels and the decarbonisation of European shipping.



→ INFINITE COOLING

EDF R&D is developing a process for recovering water from cooling tower plumes. This process, patented by an American start-up from MIT, uses an ionization mechanism to recover water from the air cooler. It recovers between 5 and 15% of the water that evaporates.





Explore EDF's R&D initiatives



edf.fr/recherche



#EDFL ab

The R&D division is hiring



edf.fr/edf-recrute



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