



OUR R&D IS ALSO YOUR R&D

*Daring to think about the future and
innovating with you in the present*



**Catalogue
of solutions
proposed by EDF R&D
to external clients**

BROWSING MY CATALOGUE...


... BY PROFILE



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EDF R&D

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The strength of
1900 energy
experts
who are working
on **your** challenges



Discover EDF R&D

1,868

employees
in France

260

employees
outside France

1,933

patents

523

million euro
budget (2019)

29 nationalities represented

156

Ph. D. students

9

centres
in France
and abroad

16

joint
laboratories
with
partners

In contact with
8,500
start-ups

4 PFlops of
computing
capacity

More than

300 academic and
industrial
partnerships

OUR AIMS



Improve EDF Group performance

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



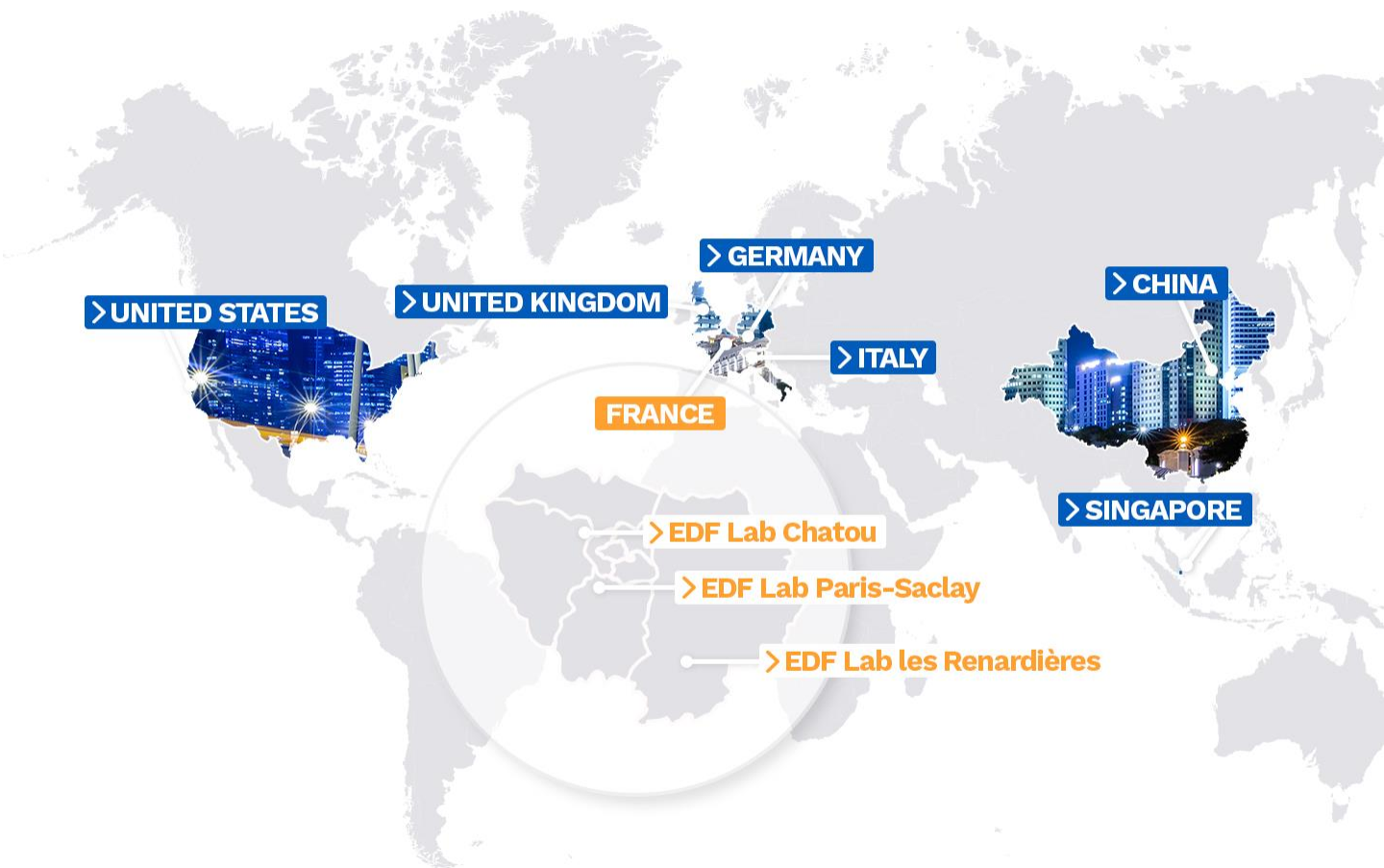
Prepare the energy scenarios of the future

by working on disruptive
technologies.



Carry out
**research for external
commissioning bodies**
within the framework of
partnerships or orders.

EDF R&D TROUGHOUT THE WORLD



OUR 3 SCIENTIFIC PRIORITIES

- 1 **Electric transition**
- 2 **Climate transition**
- 3 **Digital and societal transition**



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CONSUMPTION, CLIENTS



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INTERPRETING YOUR CUSTOMERS' ENERGY CONSUMPTION

YOUR CHALLENGES

- To know and understand the electricity and gas consumption of your customer portfolio, in order to clarify your strategic and commercial vision.
- To develop the associated personalised offers, services and counselling, which are differentiated according to your customers' energy use.
- To assess the effectiveness of implemented actions, in order to take action on your customers' consumption behaviour.

YOUR SECTOR

SOME OF OUR TOOLS AND METHODS

- > Implementation of advanced data analytics algorithms (machine learning, scoring, clustering, data analysis, etc.)
- > Econometric models on time series
- > Patented load curve clustering tools (Courboscope, Courbotree)
- > Patented models for estimating the share of hot water and heating in consumption
- > Deep-learning applied to the detection of energy uses on load curves
- > Patented base-line estimation algorithms for the modelling of individual consumption
- > Load curve estimation on representative samples (sampling plans, adjustment methods)
- > Use of clusters, R servers, and possibility of parallelising calculations

Electricity, gas, household, private and public sectors
(excluding France, Belgium, Great Britain and Italy)

OUR OFFER

- Analysis of your customers' **data**, to propose better personalised services and advices related to their consumption habits, while respecting your confidentiality constraints:
- Identification of the main factors that explain your customers' consumption.
- Assessment of the impact of cyclical events.
- Segmentation of your portfolio per homogeneous category in terms of consumption.
- Determination of typical consumption patterns that are representative of your customers, incorporating various seasonal adjustments (monthly, weekly, daily, intraday) and the impact of climate related factors.
- Estimation of your customers' energy and power requirements, depending on their characteristics, in order to optimise the targeting of your offers.
- Development of predictive **models** that enable customers to anticipate and control changes in their consumption and the associated expenses.
- Development and application of **methodologies and studies** to estimate the energy savings made through actions targeting consumer behaviour or for the measurement and forecasting of individual demand/response events in all sectors.



OUR STRENGTHS

- A specialised and multidisciplinary team in the fields of data science (various profiles of data scientists, data analysts and statisticians)
- Recognised and proven know-how that within the EDF Group (sales and marketing of energy). Excellent knowledge of the specificities and issues of the energy sector.
- Project-mode teams who are able to combine disciplinary skills and business knowledge.

THEY HAVE CHOSEN US

EDF Sales Division (2015-2017): Development of the algorithms implemented in the e.quilibre digital service, concerning the monitoring of gas and electricity consumption by residential customers

EDF Sales Division (2009-2016): "Une Bretagne d'Avance" ("Brittany in the Lead") project. Development of methods and models for the measurement of electricity consumption demand/response events.

EDF Sales Division (2017): Support for the development of a new range of offers for B2B customers (targeting and pricing of offers).

EDF Sales Division & ADEME (2014-2017): "Smart Electric Lyon" project. Assessment of the impact of the tested solutions (display of consumption, new prices, load management) on consumption behaviour.

Distribution network operator (2004-2016): Support to the distribution network operator for the management of consumption profiles, which are used operationally and in flow reconstitution systems. Participation in the development of the used profiles and their associated models.



TO FIND OUT MORE...

- > [Designing services for vulnerable populations in your territory](#)
- > [Creating new digital interaction channels with your customers](#)
- > [Planning your operations more efficiently through innovative methods](#)

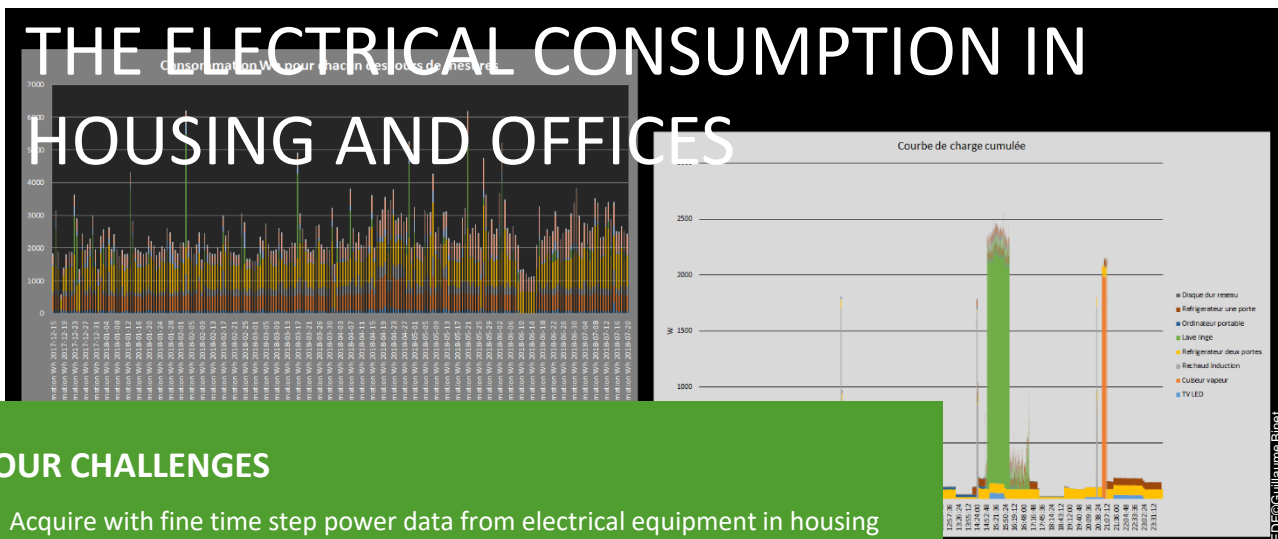
Studies and development
On quotation

Training courses
On quotation

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MEASURE, ANALYSE AND UNDERSTAND THE ELECTRICAL CONSUMPTION IN HOUSING AND OFFICES



YOUR CHALLENGES

- Acquire with fine time step power data from electrical equipment in housing and / or offices
- Perform an energy audit of your equipment
- Optimise your electricity consumption
- Develop specific algorithms based on usage (connected devices, controlling, etc.)

Examples of visualisation of measurement data

SOME OF OUR EQUIPMENT

- > A universal plug & play non intrusive measurement solution
- > Software for data treatment and analysis

OUR COMPETENCIES

- > Knowledge of residential and commercial electrical equipment
- > Know-how in performing measurement campaigns both on site and in laboratory
- > Knowledge of relevant analysis indicators

YOUR SECTOR

Residential / Commercial / Social housing / Plant operators / Start-ups / Research & Development

OUR OFFER

- Set up of acquisition infrastructure and production of validated data in various environments (housing, offices, laboratories...)
- Assistance to the selection of equipment to be fitted with instrumentation
- Detection of devices with abnormally high power consumption, diagnosis and proposal for remedial actions
- Expertise on characterisation of usage





OUR STRENGTHS

- Innovative solutions developed in house and fully mastered
- Expertise in analysing power data from electrical equipment
- Thousands days of data already acquired
- Customization to each need, each challenge and each specific context

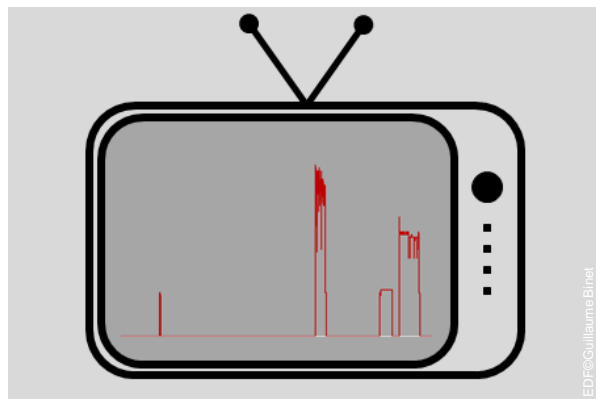
THEY HAVE CHOSEN US

Efficacity (2017/2018): office equipment load curve measurement

Distribution System Operator (2017/2018): continuous usage measurement campaign in households

EDF Réunion (2018): measurement campaign and equipment diagnosis in households

Supplier of electrical equipment (2017): characterization of power consumption of electrical devices



TO FIND OUT MORE

- > [Interpreting your customers' energy consumption](#)
- > [Simulating the electrical consumption in residential households](#)
- > [Creating new digital interaction channels with your customers](#)

Studies
On quotation

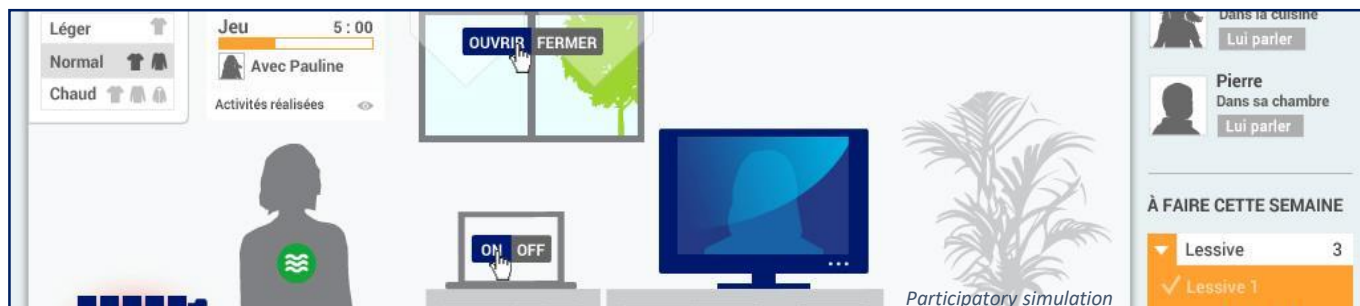
Tests and measurements
On quotation

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SIMULATING THE ELECTRICAL CONSUMPTION IN RESIDENTIAL



YOUR CHALLENGES

- To simulate the overall energy performance of a building or household, taking into account the lifestyle of its inhabitants
- To assess the effects of energy-related public policies on human behaviour and consumption
- To build your "large-scale" studies using realistic data on human activity and consumption
- To simulate the impact of an external stimulus on electricity consumption and the behaviour of households

OUR TOOLS

- Use of multi-agent simulation methods
- Incorporation of various types of modelling: human activity, building thermal analysis and electrical appliances (in a French context)
- Use of parallel cluster calculations for intensive simulations
- Scalability with the addition of supplementary models depending on requirements (e.g. electric vehicles, photovoltaic electricity production, etc.)
- Possible complementary developments to carry out analysis on other OECD countries

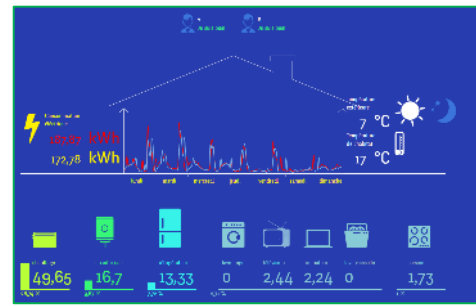
YOUR SECTOR

Energy / Distribution / Territorial development / Urban planning / General public consumer consumption / Studies and consulting / Equipment manufacturers / Residential housing

OUR OFFER

- Generation of realistic data on human activity and electricity consumption at the level of a household, a building, a district or a city **in France**. (for other countries, a period of adaptation and integration of local data is necessary).
- Testing of your policies, products and services in a simulated environment
 - Construction of a "tailor-made" study, by varying the relevant parameters (human activity, consumption, prices, geographical area, weather, year, etc.)
 - Assessment of the impact of a stimulus (price, weather, connected objects, etc.) on electricity consumption or human activity
 - Validation of your design choices through participatory simulation





OUR STRENGTHS

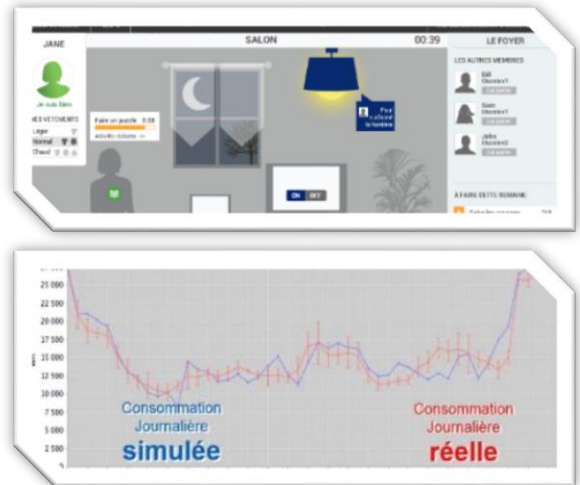
- A unique tool combining automatic simulation and manual setting of parameters, allowing to provide various studies at the local level or on a large-scale basis, using variable time steps.
- The use of INSEE statistical databases for large-scale simulations, in terms of people's schedules and the characterisation of households (person(s) that make(s) up the household, sex, age, socio-professional category, rural/urban, etc.).
- Realistic and anonymous results guaranteed.
- Recognised scientific excellence in building thermal analysis, ergonomics and multi-agent data processing.
- Partnerships with academic institutions (LIMSI, UPMC, etc.).

THEY HAVE CHOSEN US

Several dozen studies carried out and several thousand load curves delivered, including:

Smart Electric Lyon/ADEME project (2016-2017):
study on energy efficiency at the national level (simulation of 2,000 households)

EDF - Sales Division (2017):
more than 4,000 simulations delivered to calibrate commercial offers and assess the impact on consumption or human activity



TO FIND OUT MORE...

- > [Interpreting your customers' energy consumption](#)

Tailor-made studies
On quotation

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CREATING NEW DIGITAL INTERACTION CHANNELS WITH YOUR CUSTOMERS



YOUR CHALLENGES

- To identify and select the digital technologies of the future to accelerate the cultural adaptation of your customer service teams to digital technologies
- To increase the visibility of your products and services through new forms of interaction
- To use continuous improvement methods

SOME OF OUR TOOLS AND METHODS

- > Virtual reality
- > Augmented reality
- > Mixed reality
- > Serious Games
- > Connected objects
- > Artificial intelligence
- > Chatbots
- > Vocal interaction
- > Companion robots
- > Java, C, C++, Python development, etc.
- > Web development, platforms for mobile phones

YOUR SECTOR

Training, Communication, Education, Digital Transition for customer service representatives

OUR OFFER

- Identification of cutting-edge market solutions in technologies to meet your need to design:
 - Innovative digital interactions
 - Educational games to carry out your messages for training your advisors.
- Prototyping of these interactions and testing on a sample of target users
- Work in a continuous improvement loop (lean start-up method)
- Production of an internal or external communication film
- Industrialisation of the solution in your IT systems along with your teams





OUR STRENGTHS

- Proven experience in customer relations and innovative service design for the energy sector
- Continuous monitoring of developments in emerging digital technologies, virtual reality headsets (HTC Vive, Oculus Rift), augmented reality tools (ARKit, Hololens, Daqri), voice-controlled assistants (Amazon Echo, Google Home), chatbots, robots
- A team of experts in gameplay (casual games, serious games, alternate reality games)
- Access to a pool of developers with extensive experience in the field

THEY PUT THEIR TRUST IN US

EDF - Sales Division (2013-2017):

- Development of sales events (educational applications on tablets, motion interaction, interactive house, virtual reality game).
- Development of mobile applications for the real-time monitoring of consumption.
- Chatbot development and vocal interaction tests.



EDF - Sales Division (2010-2017):

- Development of training games for call centre advisors (for example, "EquipEE Digitale", an alternate reality game, and "Energy Quest", a virtual reality game on the HTC Vive headset)
- Development of games on energy savings for residential customers.

TO FIND OUT MORE...

- > [Video: "Cleanopolis" educational game](#)
- > [Designing services for vulnerable populations in your territory](#)

Design and development
On quotation

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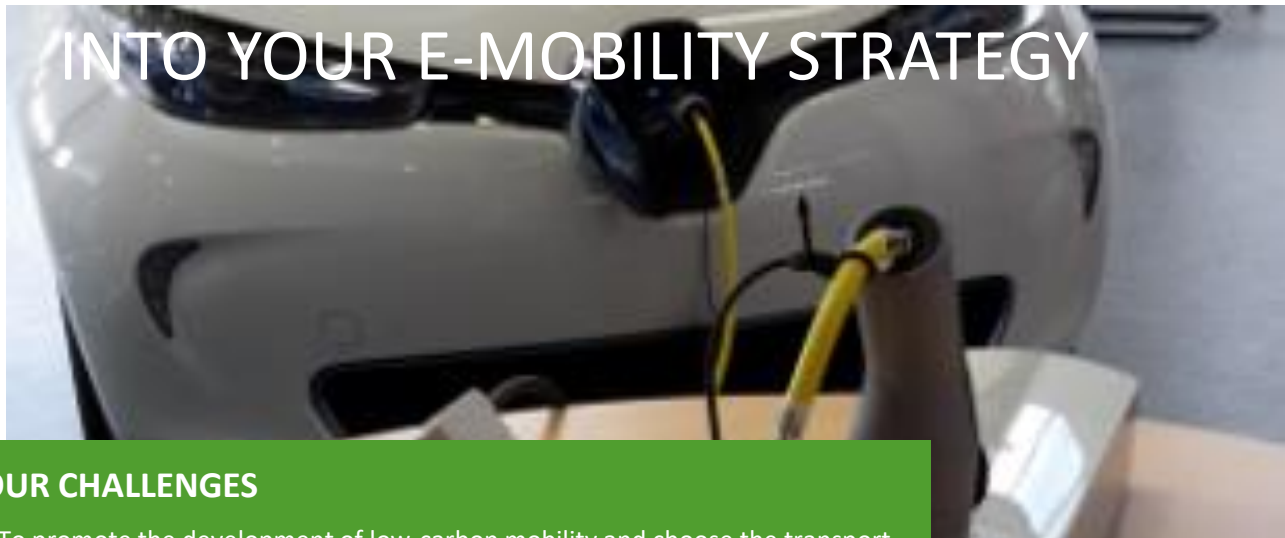


BATTERIES, MOBILITY, HYDROGEN



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INCORPORATING VEHICLE CHARGING INTO YOUR E-MOBILITY STRATEGY



YOUR CHALLENGES

- To promote the development of low-carbon mobility and choose the transport solution that best meets your criteria, while properly analysing the economic, social and environmental impact beforehand.
- To incorporate electric vehicle (EV) charging into your electrical infrastructures.
- To develop new charging solutions (induction, fast charge, etc.) for specific needs.

Assessment of a charging system on the EDF Lab Les Renardières site in Moret-sur-Loing

SOME OF OUR EQUIPMENT

- > 400kW test bench and test facility
- > Induction charging
- > EV charging stations
- > Battery testing laboratory

OUR COMPETENCIES

- > Electrical engineering
- > Smart devices
- > Numerical simulation and optimisation
- > On-board electronics
- > Norms & Standards
- > Geographic Information Systems (GIS) and geographical constraints

SECTORS OF APPLICATION

Research & development / Vehicle manufacturers / Start-ups in the field of mobility and electric charging / Local authorities / Design offices in the construction industry / Equipment manufacturers and constructors

OUR OFFER

- Assistance in energy consumption and pollutant emission diagnoses, up to the implementation of low-carbon mobility solutions.
- Consulting and expertise in the management of electric vehicle fleets in collective housing or tertiary sites.
- Support in the development of services related to electric mobility in the realm of smart devices.
- Tests of batteries and of EV charging systems and equipment.
- Prototyping of contactless charging solutions.





OUR STRENGTHS

- A test laboratory able to accommodate large-scale equipment (buses, trucks, several vehicles, etc.).
- A research and testing laboratory on batteries.
- Resources for modelling, simulation and cartographic analysis.
- Recognised expertise in electrical engineering (network impact, electromagnetic compatibility (EMC)).
- A national network and wide knowledge of power network constraints.

THEY PUT THEIR TRUST IN US

Local authorities (2015): Review of location of charging stations in several departments in France.

Distribution network operator (2016): Modelling of "electric vehicle" usage.

Charging equipment manufacturers (2016): Tests and assessment of various vehicle charging equipment.

Vehicle manufacturer (2017): Tests and assessment of vehicle charging equipment. Standardisation, standards, data collection, contactless charging.



TO FIND OUT MORE...

- > [Testing and developing your batteries](#)
- > [Validating your equipment in an experimental smart grid](#)
- > [Deploying your hydrogen-powered mobility project](#)
- > [Izivia \(EDF Group\) offers for businesses](#)

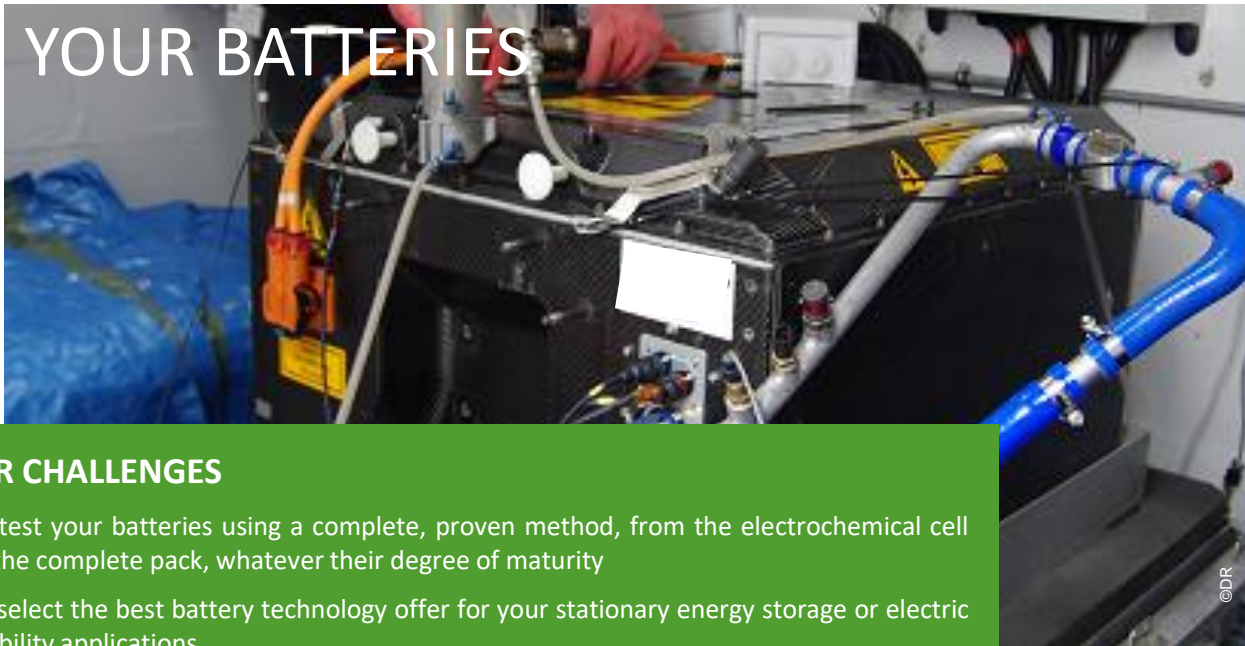
Studies
On quotation

Tests and measurements
By the day, on quotation

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TESTING AND DEVELOPING YOUR BATTERIES



YOUR CHALLENGES

- To test your batteries using a complete, proven method, from the electrochemical cell to the complete pack, whatever their degree of maturity
- To select the best battery technology offer for your stationary energy storage or electric mobility applications
- To develop new battery solutions together for your specific needs

SOME OF OUR EQUIPMENT

- > More than 300 Modular Cycling Benches up to 1000V-320kW-800A
- > 3 test laboratories able to accommodate battery cells, modules and large capacity systems
- > Large-scale climatic chambers
- > A facility dedicated to abuse tests
- > Experimentation in real electrical system on Concept Grid

SECTORS OF APPLICATION

Electric mobility and stationary electrical storage manufacturers/Start-ups who develop innovative battery technologies/Local authorities/Design offices working on the integration of batteries for renewable energies & self-consumption or electrical backup/Equipment constructors and manufacturers/Research & Development

OUR OFFER

- Complete tests on electrochemical batteries in dedicated laboratories:
 - Performance tests, cyclical ageing and calendar ageing, safety
 - Development of test methods specific to your needs by simulating all types of electrical and thermal stress scenarios
- Assessment of the security protocols to be implemented from the unit to the system and BMS analysis
- Study of needs and concerted choice of the most appropriate technology on the market to meet your stationary or mobile application requirements
- Support to develop new battery solutions:
 - Definition of needs and technical specifications
 - Development of a prototype in our dedicated laboratories
 - Consulting for the pre-industrialisation phase





EDF©Marc Caravéo

OUR STRENGTHS

- Resources for modelling, simulation and cartographic analysis
- Recognised expertise: member of the RS2E national electrochemical storage network
- An international network and extensive knowledge of battery applications
- Partnerships for additional tests (for example: STEEVE platform with INERIS)
- A research laboratory in the field of new generation batteries

1MW battery system containers

THEY PUT THEIR TRUST IN US

Local authorities and renewable energy installers: Tests and assessment of battery solutions on electric buses or renewable energy farms in isolated areas or on constrained networks (references: 20 MW on the PJM network in the USA and 50 MW for the National Grid in the United Kingdom).

Start-ups: Work with many French and international start-ups wishing to test their innovations.

Vehicle manufacturers and battery manufacturers: Tests and assessment of batteries, standardisation, data collection, exchange of technological road maps.

International Automobile Federation ("Fédération Internationale de l'Automobile" or FIA): EDF R&D is the exclusive partner for tests on batteries fitted in vehicles competing in Formula-E championships.



TO FIND OUT MORE...

- > [Testing the performance of your photovoltaic systems](#)
- > [Incorporating vehicle charging into your e-mobility strategy](#)
- > [Validating your equipment in an experimental smart grid](#)
- > [Financing your storage project: NeoT](#)

Studies
On quotation

Tests and measurements
By the day, on quotation

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DEPLOYING YOUR HYDROGEN-POWERED MOBILITY PROJECT



YOUR CHALLENGES

- To size a hydrogen service station to supply a fleet of vehicles
- To choose the most suitable suppliers for your needs
- To produce hydrogen through on-site decarbonised electricity, generating value through the optimisation of electrical control
- To equip the installation with a monitoring system enabling the remote monitoring of the installation, the diagnosis of the performance of the installation and the optimisation of maintenance

MobyPost service station co-developed by EIFER, Audincourt.

SOME OF OUR EQUIPMENT

- > Two 18 kW service stations in the Franche-Comté region with electrolysis and PV coupling
- > Sarreguemines station: 150 kW
- > Nantes station: 300 kW
- > Rodez station: 800 kW

SECTORS OF APPLICATION

Local authorities / Professional fleet managers / Service station operators / Major industrial accounts, etc.

OUR OFFER

- Project Management Assistance from preliminary design to commissioning, including pre-sizing calculations, the drafting of specifications for invitations to tender, the assessment of bids and the selection of suppliers, technical expertise during the front end engineering design phase, construction and commissioning
- Development of monitoring systems adapted to your needs for installation monitoring and preventive maintenance
- Analysis of performance of installations
- Technical and economic analyses
- Set-up of national and European research projects and programmes in hydrogen mobility
- Training in hydrogen technologies





OUR STRENGTHS

- 15 years of expertise, from laboratory to field activities, including technical and economic opportunity studies
- Know-how implemented in support of various EDF partners (cities, semi-public companies, small and medium-sized companies, large groups)
- Studies carried out for various customers within the EDF group
- Strong presence in national and European working groups (AFHYPAC, FCH-JU)
- Internationally recognised scientific excellence (publications, patents)

THEY PUT THEIR TRUST IN US

La Poste (2011-2016): Sizing of service stations in the context of the MobyPost project and project management assistance through to operation and performance monitoring.

Sarreguemines Confluences urban community (2016): Project management assistance, choice of suppliers, preparation of grant applications, monitoring.

SEMITAN (2016): Project management assistance, choice of suppliers, preparation of grant applications, monitoring.



TO FIND OUT MORE...

- > [Assessing your electrolysis and fuel cell offer](#)
- > [Incorporating vehicle charging Into your e-mobility strategy](#)
- > [Validating your equipment in an experimental smart grid](#)

Studies on quotation

Tests and measurements
By the day, on quotation

Tailor-made training possible.

Audits

By the day, on quotation

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ASSESSING YOUR ELECTROLYSIS AND FUEL CELL OFFER



©GETTY IMAGES

YOUR CHALLENGES

- To deploy economically viable clean and low carbon H₂-energy systems
- To operate an available, reliable and robust H₂-system, with a technology mix
- To improve and optimize H₂-systems performances and lifetime
- Minimise the H₂-systems costs

AN INNOVATIVE APPROACH

- > Replacement of standard failure prevention based on pre-defined regulation control of operation parameters
- > Easily on-line implementable diagnosis / prognosis algorithms implying smart control system
- > A potentially non intrusive plug and play solution

SECTORS OF APPLICATION

Fields:

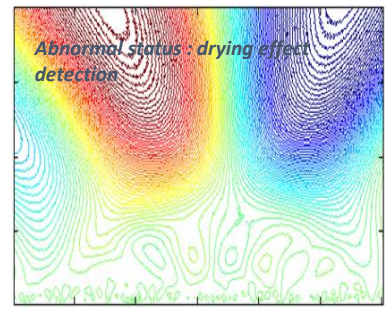
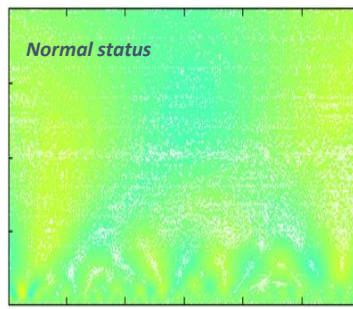
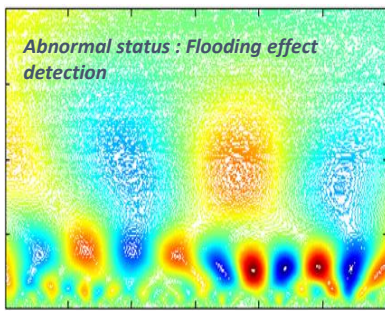
- Automotive sector
- Decentralized power generation sector (residential, tertiary services, industries)
- Chemical industries and hydrogen production
- Uninterruptible Power system for Isolated / Sensitive / Off-grid areas

Customers: Manufacturers and Operators of electrochemical power systems (Fuel cells and Hydrogen technologies, batteries, etc.)

OUR OFFER

- Technical expertise in fuel cell and water electrolyser technologies, and on deployable solutions for different use cases.
- Non intrusive tools and methodologies to detect and identify faulty conditions on an electrochemical device *in operando*.
- Tailor made algorithm tools and methodologies to follow the state of degradation of an electrochemical device and estimate its remaining useful lifetime for a better planned maintenance and higher availability.
- Tailor made control tools to optimise the system's operating point.





Non intrusive, plug and play method to identify system faults into polymer-based fuel cell unit

OUR STRENGTHS

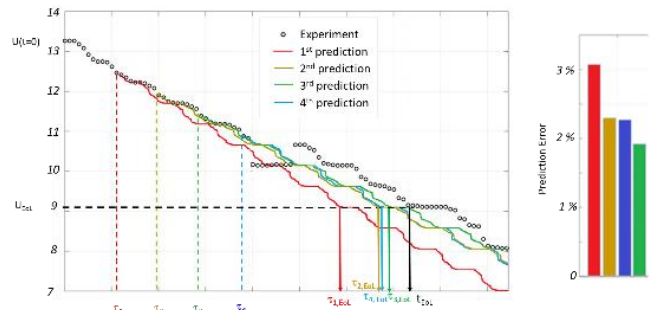
- A high level of knowledge in the understanding of the physics underlying the faults and the degradation modes of fuel cells and hydrogen production devices.
- A high level of expertise in the development of algorithms for faults detection / identification / localization and for lifetime improvement, consolidated by patents portfolio (>4 patents).
- Experimental facilities for long term testing and electrochemical characterisation of systems under customized operating conditions.
- A network of excellence (publications, patents) in partnership with strategic academic institutions and industries at national and European levels.

THEY PUT THEIR TRUST IN US

Agence Nationale de la Recherche (since 2006): Development of algorithms for fuel cell based electric mobility. The French research national agency funding is an acknowledgement of our level of expertise.

Fuel Cell and Hydrogen Joint Undertaking (since 2009): Development of diagnostic algorithms for fuel cell based combined heat and power unit in residential application. (European Union funding)

EDF (2014-2016): Lifetime prediction algorithm with less than 5% of error.



Performance prediction and remaining useful lifetime estimation

TO FIND OUT MORE...

- > [Deploying your hydrogen-powered mobility project](#)

Tailor-made offer on quotation

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ENERGY IN BUILDINGS



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TESTING THE PERFORMANCE OF YOUR BIOCLIMATIC SOLUTIONS FOR BUILDINGS



EDF®

Laboratory for building envelope and solar technologies tests on the EDF Lab Renardières site, Moret Loing and Orvanne, France

YOUR CHALLENGES

- To design and optimise your bioclimatic technologies for residential and non-residential buildings.
- To carry out full-scale tests and validate the performance of your building-integrated systems for renovation and for new construction works.
- To characterise and analyse your innovative components in detail under real conditions.
- To develop and validate a digital twin of your systems for your field applications.
- To demonstrate the benefits of your innovations from their installation to their dismantling through a measurement campaign

SOME OF OUR EQUIPMENT

> 12 adiabatic cells, equipped with a test facade (East, South, West) facing the outdoor climate

- 6 cells in wall configuration
- 6 cells in roof configuration

> 2 full-featured weather stations for outdoor climate measurements

> management of the internal cells' temperature

> temperature and humidity sensors and energy-consumption monitoring equipment for a complete energy assessment of the technologies

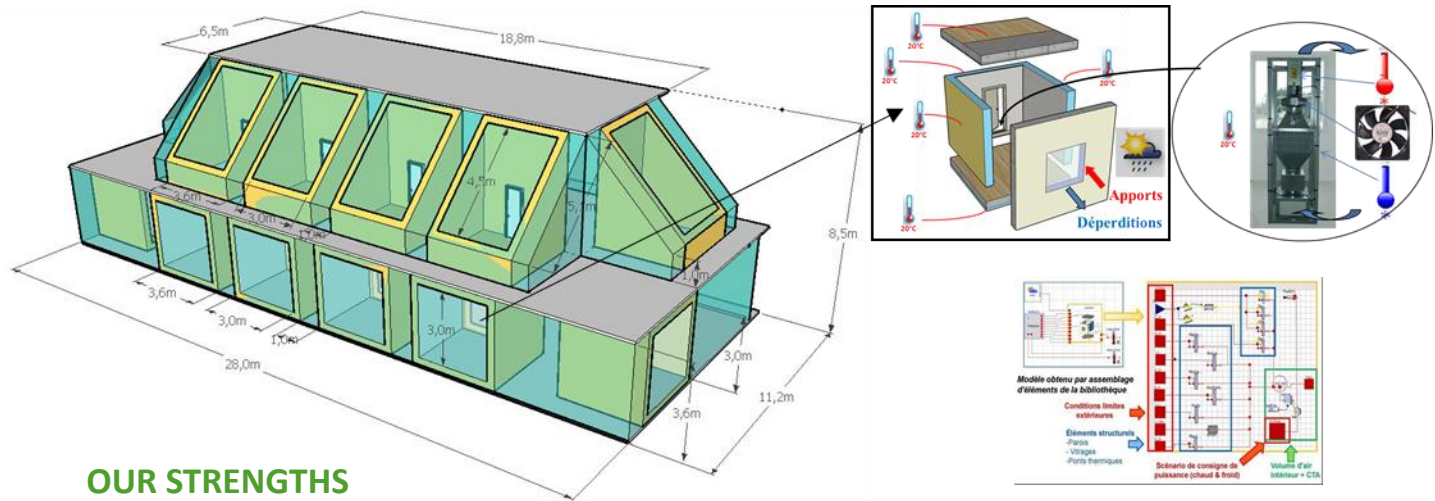
YOUR SECTOR

Active facades, which adapt their behaviour to their environment and to the occupants' needs, connected or not to technical equipment. Solar and/or bioclimatic technologies.

OUR OFFER

- Support in the design of innovative technologies suited to smart buildings and incorporated into their environment (outdoor climate, urban block).
- Provision of facades for the installation and testing of complete technologies.
- Experimental tests in a real (outdoor climate) and in a controlled environment
- Identification of areas for improvement through combined laboratory/modelling analysis.
- Development and validation of digital technologies for replication





OUR STRENGTHS

- Technical expertise in building technologies (walls, ventilation) that is internationally recognised by academic and industrial partners.
- Fully adaptive test resources, enabling the comparison of systems for all orientations and for all types of facade.
- Multiphysical characteristics modelling tools, allowing studies from the material scale to the building and district scale .
- Internationally recognised scientific excellence (peer reviewed publications, awards, professorship in higher education), especially in the field of materials and transfers (thermal, hydric, aerualic) .

THEY HAVE CHOSEN US

Manufacturers of building envelope solutions: co-development of innovative building envelope solutions; laboratory testing of technologies to analyse their performance under real conditions.

Academic partners renowned in the field of research and development in the “building of the future” area: collaborative research works and projects, joint laboratories ([4EVLab](#), [MATEB](#), [BHEE](#) – in French only)

Regional partners: guidance for technological solutions for retrofitting and for new buildings construction.



TO FIND OUT MORE...

- > [Testing the performance of your photovoltaic systems](#)
- > [Testing the performance of your thermo-dynamic equipment](#)
- > [Simulating tomorrow's sustainable city](#)
- > [Testing and optimising your lighting](#)

Tests and measurements
On quotation

Prototyping
On quotation

Studies
On quotation

CONTACT

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TESTING THE PERFORMANCE OF YOUR THERMODYNAMIC EQUIPMENT



EDF © Philippe Eranian

YOUR CHALLENGES

- To characterise and approve equipment for the production of heating or domestic hot water in residential or tertiary buildings
- To optimise energy equipment by improving its performance (energy consumption, thermal comfort, customer invoicing, etc.)
- To think up and design innovative energy equipment

Prototyping laboratory on the EDF Lab
Renardières site in
Moret-sur-Loing.

SOME OF OUR EQUIPMENT

> 1 laboratory with climate-controlled temperature [-15°C, +45°C] and relative humidity [5%, 90%]

- 1 climatic chamber for centralised solutions (collective housing, tertiary) up to 500kWth

- 7 climatic units up to 20kWth for individual residential solutions

> 1 prototyping laboratory enabling the design of innovative machines

> 1 real-climate laboratory equipped with several test benches and underground geothermal sensors

SECTORS OF APPLICATION

Manufacturers of heat pumps (air-air, air-water, water-water, fuel hybrids, gas hybrids, geothermal) and thermodynamic water heaters/Boiler manufacturers/Designers of innovative energy systems

OUR OFFER

- Trial and test campaigns on energy equipment in a controlled or real environment, and for simulated (semi-virtual) consumption scenarios.
- Identification of ways to improve your equipment or products through combined laboratory/modelling analysis.
- Prototype design, commissioning and tests in our laboratories.



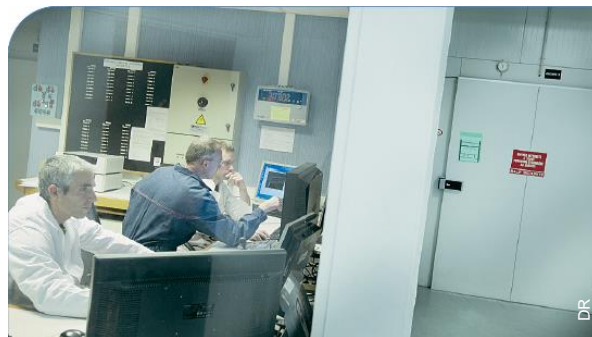


OUR STRENGTHS

- Recognised technical expertise for the global industrial sector.
- Powerful test resources providing multiple possibilities through unique semi-virtuality.
- Several years of experience in prototyping.
- Numerous field monitoring operations that reinforce our knowledge of real system operation.
- Internationally recognised scientific excellence (publications, awards, higher education).

THEY PUT THEIR TRUST IN US

Several dozen energy equipment manufacturers:
Laboratory tests of around a hundred products to analyse their performance under controlled or real conditions.
Support for technological solutions destined for the new equipment market.



TO FIND OUT MORE...

- > [Innovating with and for you through design](#)
- > [Testing and optimising your lighting](#)
- > [Dalkia \(EDF Group\), leader in energy services](#)

Tests and measurements
Available on quotation

Prototyping
On quotation

Studies
On quotation

Brainstorming
On quotation

CONTACT

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STUDYING THE OPPORTUNITY TO INVEST IN COOLING STORAGE



©DR

Cooling storage laboratory
on the EDF Lab Renardières
site in Moret-sur-Loing

YOUR CHALLENGES

- To maximise energy savings and reduce operating and maintenance costs, by optimising your cooling production installations and improving their reliability.
- To reduce your environmental impact.
- To ensure return on your future investments by opting for an objective personalised study that is adapted to your particularities.

SOME OF OUR EQUIPMENT

Sizing software based on:

- > Field audits
- > Laboratory experiments
- > A technology watch
- > Significant feedback
- > An update of pricing conditions
- > Daily and annual optimisation
- > Assessment by our researchers

SECTORS OF APPLICATION

In France and abroad

- Air-conditioning: tertiary buildings (hotels, hospitals, swimming pools, museums)/Data centres
- Process cooling: Agri-food industry/Chemical industries/Mass catering/Mass retail/Urban cooling network

OUR OFFER

Realisation of a sizing and optimisation study for a future thermal cooling storage facility associated with a cooling production installation to:

- Help in the assessment of the technical and economic benefit of setting up thermal storage (energy savings, savings on invoices, impact on sizing and investment, impact on your electricity tariff and contract power, etc.).
- Identification of the best technical solution for your situation (with complete neutrality with respect to manufacturers).
- Have a design for a durable, optimised solution.





OUR STRENGTHS

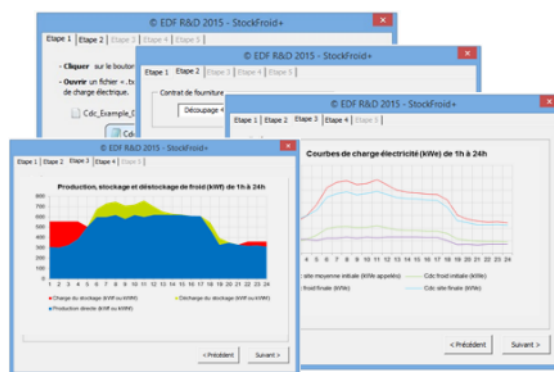
- Technical expertise in cooling production and storage solutions
- Laboratory-approved modelling and sizing tools
- More than 100 audit and diagnosis operations carried out on the premises of EDF or Dalkia (EDF Group) customers
- Subsidiaries to potentially support you in implementation, maintenance and operation work

THEY PUT THEIR TRUST IN US

Urban network (2016): Sizing of a cooling storage solution to increase new customer connection capacity. Study followed by work.

Mass retail (2016): Study of the refurbishment of a cooling production facility for the mass retail sector, incorporating the use of cooling storage to improve performance. Study followed by work.

Office air conditioning (2016): Pre-study of the installation of cooling storage to improve reliability and reduce cooling production costs.



TO FIND OUT MORE...

- > [Testing and optimising your industrial cooling installation](#)
- > [Training your staff in industrial energy efficiency](#)
- > [Choosing the right algorithm for your operational decisions](#)
- > [Dalkia \(EDF Group\), leader in energy services](#)

Audits
On quotation.

Tests and measurements
By the day, on quotation

Studies
On quotation

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ENERGY IN FACTORIES



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IDENTIFYING INTER-COMPANY ENERGY AND MASS EXCHANGES



YOUR CHALLENGES

- To foster Industrial Ecology into your industrial park.
- To gain in competitiveness by developing energy/mass exchanges with neighbouring companies.
- To have a better control of energy and mass consumption (e.g. water) in your industrial area.
- To reduce the environmental impact within your territory.
- To increase recycling rates of waste heat by your equipment and processes and to share it with your industrial neighbours through heat networks.

SOME OF OUR TOOLS

- > Proprietary modelling and optimisation software:
 - RECYTER (targeting of potential energy and mass exchanges)
 - PHOENIX (economic optimisation of heat/cold and mass networks and production resources)

YOUR SECTOR

Industrial and business parks

OUR OFFER

- A support in ambitious and reasoned analysis to foster a better control of your environmental impacts and in the sharing of waste/resources with your neighbours within your territory.
- Mapping of the potential for recovery and exchange of your territory's mass and energy flows (e.g. waste heat).
- Assistance in decision-making concerning the best technical-economic solutions for the design of heat and mass exchange networks in your territory (OPEX/CAPEX calculations, environmental impacts, internal rate of return, etc.).
- Design of heat/cold and material network paths, taking into account spatial constraints.
- Design of new means of production of heat and cold production, in addition to energy networks and heat recovery systems (heat pumps, ORCs, etc.).
- Design of the mass exchange networks and the required processing units.



OUR STRENGTHS

- A vast know-how and track record; by a team of experienced engineers in the following subjects: energy/mass integration, heat networks and industrial processes.
- In-depth knowledge of industrial sites and industrial activity zones.
- A targeting tool dedicated to inter-site heat and mass exchange potential based on sectorial and real data (RECYTER).
- A software platform for optimisation and decision-making, enabling the integration of energy and mass via heat, cold and mass networks (PHOENIX), enabling the analyses of various realistic scenarios.

THEY HAVE CHOSEN US

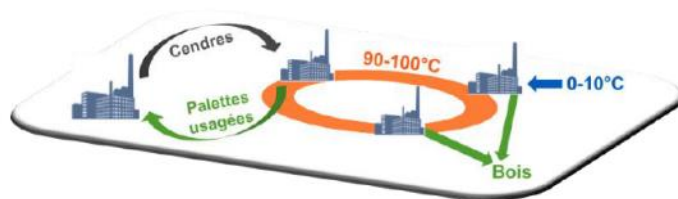
Vitry le François industrial area (2014):

Launch of an industrial and territorial ecology approach, by proposing mass and energy exchanges and synergies based on sectorial and real data

Métropole Savoie cold network (2015):

Prospective study on the implementation of a cold network, powered by energy recovery from the Le Bourget lake water

Dunkirk industrial harbour area (2017): Identification of exchange potentials for heat and cold networks



TO FIND OUT MORE...

- > [Optimising your consumption and your energy mix](#)
- > [Testing the performance of your thermodynamic equipment](#)
- > [Training your staff in industrial energy efficiency](#)

Studies
On quotation

CONTACT

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RECOVERING THE WASTE HEAT OF INDUSTRIAL PROCESSES



Laboratory at the EDF Lab in
Les Renardières

YOUR CHALLENGES

Industrial customers

- To assess the benefit of waste heat recovery operation from among a panel of choices: ORCs, heat pumps, thermo-refrigerating pumps, heat exchangers, absorption heat pumps, thermal storage, etc.
- To optimise your processes in terms of energy by using the most suitable solution.

Equipment manufacturers

- To characterise and validate recovery technologies or systems.
- To develop a research programme and/or build test facilities to design your future innovations.

SOME OF OUR EQUIPMENT

> Test benches for Water/Water-type system tests

> Cold source:

Power of 600 kWth

Temperature of 15 to 100° C

Flow rate of 10 to 55 m3/h

> Heat source:

Power of 1MW

Temperature of 15 to 150° C

Flow rate of 10 to 55 m3/h

> Sensible heat storage (1m3 at 120° C)

YOUR SECTOR

Thermal equipment manufacturers / Food industry / Chemical and plastics industries / Industrial dryers / Heat networks / Research & development

OUR OFFER

For industrial customers:

- Audits on the potential for waste heat recovery on your facilities. Training by our experts.
- Modelling of heat production installations and optimisation of their design and management.
- Assistance in project design, construction and project management for the implementation of identified optimal solutions.

For equipment manufacturers:

- Characterisation of your products in terms of operating range, endurance test, instrumentation and control test, partial load operation, stop-start cycles, mapping of performance under various thermal conditions, etc.
- Assistance for preparation of projects and research programmes, search for grants and financing.





OUR STRENGTHS

- More than 10 years of experience in audits and diagnostics carried out on the premises of EDF and Dalkia industrial customers.
- Training courses for a variety of profiles (maintenance operators, design engineers, etc.).
- Internationally recognised scientific excellence (peer reviewed publications, awards, higher education training).

THEY HAVE CHOSEN US

Johnson Controls: R&D programme and tests for the development of unique heat pump, first of its kind in the world.

Johnson Controls: testing of a high temperature (120°C) heat pump, complete performance mapping.

Clauger: co-development of a high temperature (105°C) heat pump.

Cristopia: testing of phase change nodules behaviour for heat storage.

Various industrial customers: guidance in waste heat recycling projects in their plants.



TO FIND OUT MORE...

- > [Testing the performance of your thermodynamic equipment](#)
- > [Optimising your consumption and your energy mix](#)
- > [Dalkia \(EDF Group\), leader in energy services](#)

Tests and measurements
By the day, on quotation

Training courses
On quotation

Studies
On quotation

Audits
By the day, on quotation

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TESTING AND OPTIMISING YOUR INDUSTRIAL COOLING INSTALLATION



YOUR CHALLENGES

- To characterise and approve equipment or an integrated solution for cooling production in tertiary or industrial buildings
- To perform a diagnosis on cooling installations
- To optimise cooling installations by choosing and deploying the solution best suited to your needs
- To define a research programme and/or develop test resources associated with industrial cooling

R507 chiller unit on the EDF
Lab Renardières site in
Moret-sur-Loing.

SOME OF OUR EQUIPMENT

- > 1 MW heat sink
- > 1.3 MW heat source
- > 1 MWh programmable latent storage
- > 0-188kW variable boiler
- > Over-instrumented R507 chiller unit

SECTORS OF APPLICATION

Agri-food Industry/Chemical and plastics industries/Mass retail/Refrigeration and air handling/Data centres/Research & Development

OUR OFFER

- Trial and test campaigns in the fields of thermal performance and instrumentation and control on chiller units, cooling and refrigerant fluid storage in a controlled environment.
- Expert audits on site.
- Modelling studies of cooling installations and optimisation of their sizing and control.
- Assistance in project design and construction supervision to implement optimisation solutions.
- Set-up of research projects and programmes in the field of industrial cooling.
- Training in industrial cooling asset management for operators, energy managers and financial managers.





OUR STRENGTHS

- 10 years of audits and diagnoses carried on the premises of EDF or Dalkia customers.
- Know-how implemented in support of Cesbron (Dalkia, EDF Group).
- Training provided for a wide range of audiences (maintenance operators, study engineers, etc.).
- Internationally recognised scientific excellence (publications, awards, higher education).

THEY PUT THEIR TRUST IN US

Heating network (2015): Simulation of cooling storage to increase the capacity of urban air-conditioning networks, in order to allow connection of 30% additional customers.

Mass retail (2016): Pre-study of the refurbishment of a cooling production facility for the mass retail sector, incorporating the use of cooling storage to improve performance. Offer followed by work

Agri-food industry (2016): Tests of advanced cooling system control solutions on pilot sites, 5% reduction in the customer's electricity bill.

ADEME project (2016): Improvement in the energy and technical performance of equipment by monitoring and optimising regulations.



TO FIND OUT MORE...

- > [Studying the opportunity to invest in cooling storage](#)
- > [Training your staff in industrial energy efficiency](#)
- > [Guaranteeing the performance of your electric motors](#)

Training

On quotation. Tailor-made training possible.

Audits

On quotation.

Studies

On quotation

Tests and measurements

By the day, on quotation

CONTACT

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OPTIMISING YOUR CONSUMPTION AND YOUR ENERGY MIX



YOUR CHALLENGES

- To improve competitiveness by reducing your energy and water consumption.
- To reduce the environmental impact of your company.
- To recover waste heat available in your site in a more efficient manner.
- To optimise the incorporation of renewable energies into your energy mix.

SOME OF OUR TOOLS

- > Dedicated and proprietary modelling and optimisation software:
 - PHOENIX (economic optimisation of heat/cold and mass networks and production resources)
 - ETEM (medium-term economic optimisation of the energy mix)

YOUR SECTOR

Industrial processes, industrial facilities

OUR OFFER

- Mapping of energy and mass recovery potentials within the industrial site.
- Technical-economic optimisation of the design of heat and mass exchange networks on your process.
- Design of new means of production of heat and cold, as well as heat recycling systems (heat pumps, ORCs, etc.).
- Design of processing units.
- Study of the medium-term profitability of a new energy mix, taking into account a prospective energy price scenario.



OUR STRENGTHS

- Proven track record in energy/mass integration and industrial process modelling and in energy prospection and medium-term scenarios.
- Sectorial know-how as well as on-field knowledge, at the heart of industrial processes.
- Optimisation and decision-making assistance software platforms: PHOENIX, to design heat and mass exchange networks, as well as heat production and recycling systems (heat pumps, ORCs, etc.); and ETEM, for the medium-term economic optimisation of the energy mix and the study of the integration of renewable energy sources.

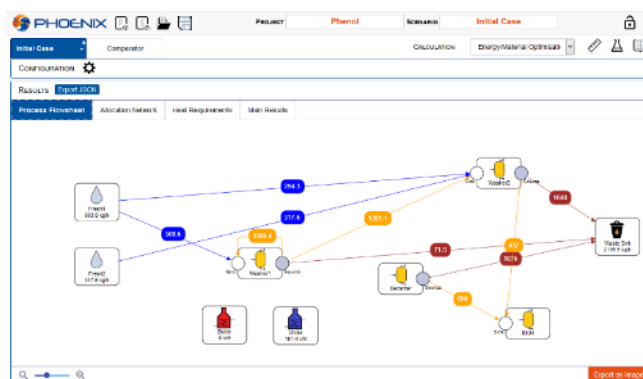
THEY HAVE CHOSEN US

Paper manufacturer (2014): Design of heat exchangers for the recovery of waste heat using heat pumps

Food industry (2014): Waste heat recovery study at the overall site level, with high energy savings.

Oil Refinery (2015): Water network diagnostic and proposal of a more efficient and economically relevant network to improve the reliability of an installation.

ArcelorMittal (2018-2020): Siderwin European consortia and project, to deploy an electrolysis manufacturing technology for steel making



TO FIND OUT MORE...

- > [Testing the performance of your thermodynamic equipment](#)
- > [Training your staff in industrial energy efficiency](#)
- > [Identifying inter-company energy and mass exchanges](#)

Studies
On quotation

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TRAINING YOUR STAFF IN INDUSTRIAL ENERGY EFFICIENCY

YOUR CHALLENGES

- To know the operating principles of your energy and fluid supplies and to identify the issues and levers (financial, regulatory, etc.) of energy efficiency
- To know the technical solutions, to master best practices and to detect installation operating deviations
- To study the possible implementation of modifications on your own installations and to quantify their technical and economic benefits
- To share the same level of knowledge and skill among all your energy managers

SOME OF OUR EQUIPMENT

- > Industrial cooling laboratory, glycol water loop, thermal cooling storage
- > Heat pump and heat storage laboratory
- > Lighting laboratory
- > Compressed air installation

SECTORS OF APPLICATION

All sectors: industrial, tertiary, local authorities

OUR OFFER

Training programmes that can be customised to meet your needs:

- Know, assess and control energy performance indicators
- Become familiar with the normative and regulatory context of energy efficiency
- Master benchmark energy audit methods (EN 16247)
- Know the operating principles of energy supplies and services (heat, cooling, ventilation (HVAC), motorisation, lighting, waste heat recovery, etc.)
- Practical work on our laboratory equipment and studies of your actual cases.
- Benefits of energy monitoring (metering, supervision, analysis, etc.)

The trainee leaves with an operational list that he/she can directly implement on his/her installations

These training courses may be completed by accompanying the trainees during **audits** on the customer's sites.





OUR STRENGTHS

- Each module is presented by EDF R&D experts who have carried out numerous audits on our customers' premises. This knowledge of real field conditions enables a detailed exchange that is greatly appreciated by trainees.
- Our training courses are based on practical work in our numerous laboratories, for directly applicable knowledge.
- Our expert trainers are neutral with respect to manufacturers, so it is possible to compare the performance of your various sites.

THEY PUT THEIR TRUST IN US

Aeronautics industry (2014): 30 industrial site energy managers trained and then accompanied during audits.

Metallurgy industry (2015):

40 site energy managers have been trained, training included in the training plan for energy managers.
20 buyers trained in utility diagnosis in the context of the training required by ISO 50 001.

Automotive industry (2014/2016): 80 site energy managers have been trained, training included in the training programme for energy managers.

Luxury industry (2014): 20 production site energy managers have been trained.



EDF@Jean-Lionel Dias

TO FIND OUT MORE...

- > [Testing and optimising your industrial cooling installation](#)
- > [Guaranteeing the performance of your electric motors](#)
- > [Identifying inter-company energy and mass exchanges](#)
- > [Dalkia \(EDF Group\), leader in energy services](#)

Training

On quotation. Modular training courses.

CONTACT

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POWER NETWORKS AND ELECTRICAL SYSTEMS

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VALIDATING YOUR EQUIPMENT IN AN EXPERIMENTAL SMART GRID



EDF©William Beaucardet

YOUR CHALLENGES

- To validate the incorporation of new equipment or a new solution into the power distribution network under real conditions
- To accelerate the development of your technology by pushing it to its operating limits, while fully controlling test conditions
- To eliminate the risks associated with your technology by confronting it with disrupted and reproducible situations, in order to ensure a secure installation in the field

*Concept Grid housing district,
on the EDF Lab Renardières
site in Moret-sur-Loing*

SOME OF OUR EQUIPMENT

- > Aerial and underground MV/LV networks
- > Primary substations, distribution substations
- > Fibre-optics across the entire network for:
 - Instrumentation and control (in accordance with the IEC 61850 standard)
 - Experimental functions
- > Houses for usage integration (batteries, mini-wind turbines, EVs, PV, etc.)
- > Four-quadrant linear power amplifier (120/60 kVA) coupled to a real-time simulator (Power Hardware In the Loop - PHIL)
- > Short circuit breaker
- > Neutral point arrangement change control device
- > Connection to other site laboratories (PV, EV, lighting, heat pumps, etc.)

SECTORS OF APPLICATION

Network equipment/Microgrids/Battery storage/Flywheels/Super-capacitors/Electric vehicles (EVs)/Photovoltaic (PV) installations/Energy Management Systems (EMS)/Telecom compatibility: powerline communication (PLC), IEC-61850/Real-time simulation/Co-Simulation

OUR OFFER

- Precise study of your need (if necessary, pre-testing performed by us to adapt the Concept Grid to your issues)
- Test campaigns in real situations on an experimental electrical system that is representative of reality
- Study of hardware and software integration
- Realisation of test scenarios in normal and disrupted situations: short circuits, voltage dips, harmonic pollution, etc. Possibility of reproducing real U/I signals recorded in your field
- Test reproducibility and speed of execution (*ex: 60 Medium Voltage short circuits in one week on a real network*)
- Complete test report including the measurements carried out in accordance with your needs





EDF©Marc Carayon

OUR STRENGTHS

- A unique test resource with great flexibility (wide range of tests): Concept Grid
- Installations that ensure the representativeness of real field conditions and the possibility of creating extensive disruptions
- A team fully dedicated to the study of your needs and the performance of your tests
- The possibility of using Concept Grid as a showcase for your achievements (visits, publications, etc.)

THEY PUT THEIR TRUST IN US

Nice Smart Valley: Simulation in Concept Grid of the architecture of the actual electric network of the Lérins Island with the integration of two battery storage systems. Before commissioning on the island, carrying out network stability tests in all possible configurations and various load profiles, tests of transient phases in uninterrupted pilot mode, tests of network protection plan (MV defaults and LV short-circuits).

Ventee project: Tests on several pieces of network equipment: MV/LV transformers with on-load tap changers, network recloser, overhead fault detector (30 years of feedback in one week).

EDF Business Unit: Validation of operations and performance of an EMS (Energy Management System). Creation of a microgrid with several devices (diesel generator, battery storage, PV, sensors, loads...). Test of the optimal control of devices with the EMS in order to provide services to the client and to the network operator. Test of various scenarios (following a power set point at the coupling point, frequency control service, management of time-of-use pricing...)



EDF©William Beaucardet

TO FIND OUT MORE...

- > [Networks Lab: concept grid](#)
- > [Concept grid on YouTube EDF](#) (video in French)
- > [Power tests and high voltage tests](#)
- > [Protecting your equipment against electrical transients](#)
- > [Testing and developing your batteries](#)

Price of a Concept Grid test:

The price fluctuates depending on the scope, duration and complexity of the test envisaged. An initial study of your need is necessary and will result in a cost estimate. Please feel free to contact us!

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TESTING & ASSESSING YOUR ENERGY METERING SOLUTIONS

YOUR CHALLENGES

- To deploy new smart metering systems
- To assess and test new metering equipment
- To check equipment compliance with respect to international metering standards
- To master the applications provided by the G3 PLC powerline communication technology

EXAMPLES OF LAB EQUIPMENT

- > Climatic test chambers with automated temperature & humidity cycling
- > Advanced test benches (metrological, functional, communications)
- > Electromagnetic compatibility tests (fast transients, surge immunity)
- > Electrical safety tests (dielectrics, shock waves)
- > Test tool for customer information interface

APPLICATION SECTORS

Power Distribution and Supply Companies
Metering Asset Operators & Providers
Metering Equipment Manufacturers

SERVICE OFFER

- Consulting and project management assistance in the preparation and execution of call for tenders for the manufacture and deployment of smart meter systems.
- Support in the preparation of equipment test plans in order to guarantee asset reliability and robustness throughout the product service life.
- Consulting and expertise in product fault analysis.
- Consulting services for quality monitoring of installed equipment.
- Support and execution of meter manufacturing process audits.
- In-house test services for climatic, environmental (ageing) and electrical tests.
- Control of compliance of customer interfaces, equipment related with or connected to the smart meters (such as in-home displays).
- Support and expertise in the field of the G3-PLC powerline communication technology.





©DR

OUR STRENGTHS

- More than 25 years' experience in the field of specifications and tests on electronic, residential and industrial meters
- Deep knowledge writing the specifications and running the tests of most residential and C&I meters deployed on the distribution network in France
- Expertise resulting from more than 25 years of in-service monitoring of the French metering fleet
- Experts present in international metering and communication standardisation groups, members of the IEC, CENELEC, DLMS User Association, G3 PLC Alliance and LoRa Alliance

THEY TRUST US

Enedis: Since the first industrial solid-state meter (CVE) in the 1990s, EDF R&D has been involved in writing the specifications, running compliance and performance tests and monitoring metering assets. The latest meters tested to date are the SAPHIR meter (for MV customers) and the Linky® meter.

SEI - EDF Insular Power Systems: Support in the deployment of smart meters, particularly by working on the durability of the meters in tough tropical environments (through use of specific rigorous climatic tests)

EDF Energy: Support of the smart meter programme in Great Britain.



TO FIND OUT MORE...

- > [Protecting your equipment against electrical transients](#)

Consulting & expertise
On quotation

Tests and measurements
On quotation

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GUARANTEEING THE QUALITY OF ELECTRICITY IN YOUR POWER NETWORK



EDF © MURAT GUILAUME

YOUR CHALLENGES

- To develop methods, processes and decision-making support tools for the development of networks that integrate renewable energies and new uses
- To develop harmonic interference models of new uses, in order to predict their impact on networks
- To develop and optimise disturbance testing and measurement resources

OUR TOOLS

- > HLF (Harmonic Load Flow): laboratory tool used to simulate, analyse and model power networks with representation of harmonics
- > ExpertEC: customer power network simulation, analysis and pre-sizing tool
- > Optame: tool to assist in the analysis of measurement data
- > Power Factory (from the DigSilent company): modelling, simulation and analysis of power networks

SECTORS OF APPLICATION

Designers and operators of public distribution and transmission networks and the internal power networks of industrial, tertiary and residential customers

OUR OFFER

- Realisation of measurements on customer sites or distribution networks, extensive diagnosis of the origin of interference, consulting on the solutions to be implemented
- Laboratory testing of new uses and analysis of possible associated interference
- Realisation of models of the interference observed in laboratories
- Modelling and simulation of power networks, incorporating new uses and their disturbances



OUR STRENGTHS

- A continuous capitalisation approach, based on measurements carried out on sites and in laboratories, enabling us to improve our simulation models
- Regular enhancement of our tools to enable the study of new uses and new decentralised production systems, and extension to other energy networks
- Internationally recognised scientific excellence (publications, awards, higher education) supported in standardisation groups

THEY PUT THEIR TRUST IN US

Distribution network operator: Development of simulation modules specific to their needs, in order to better characterise the integration of renewable energies and new uses and thus to optimise the development of their networks

Energy provider: Development of specific tools for their experts, realisation of assessments on industrial sites, in order to determine the causes of the interference observed and to propose solutions

Transmission network engineering: Simulations of the integration of new renewable energies into the transmission network

High-technology company: Simulations and validation of the models used by this company in the characterisation of electrical interference



TO FIND OUT MORE...

- > [Protecting your equipment against electrical transients](#)
- > [Guaranteeing the performance of your electric motors](#)
- > [Ensuring the reliability of your industrial power networks](#)

Training
On quotation
Tailor-made training possible.

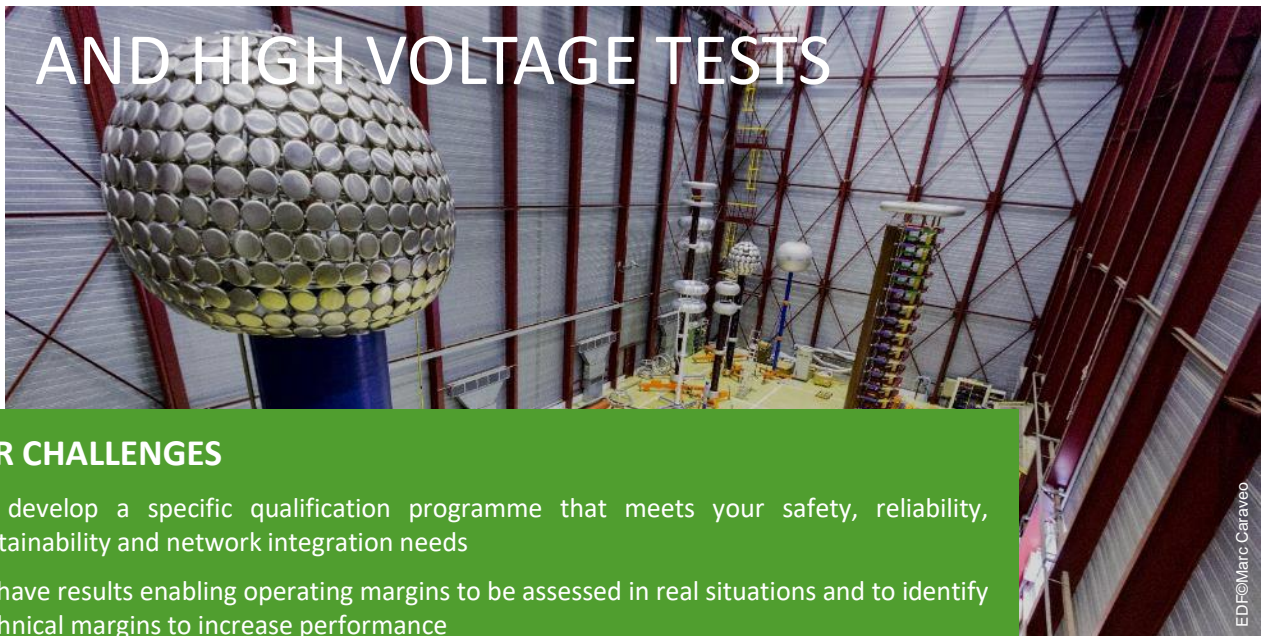
Studies
On quotation

Measurements, Tests and Assessments
On quotation

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POWER TESTS AND HIGH VOLTAGE TESTS



EDF/Marc Caraveo

420 kV facility on the EDF
Lab Renardières site in
Moret-sur-Loing

YOUR CHALLENGES

- To develop a specific qualification programme that meets your safety, reliability, sustainability and network integration needs
- To have results enabling operating margins to be assessed in real situations and to identify technical margins to increase performance
- To objectify real service lives, in order to ensure that renewal programmes run smoothly
- To adapt your equipment to changes in electrical systems: integration of renewable energies (intermittence), smart grids (operation rates)

SOME OF OUR EQUIPMENT

3,200 MVA High Power Laboratory

- > Short circuit:
 - Up to 120 kA – 3 s
 - Cables/Conductors/Accessories
 - Transformers, Disconnector switches,
 - Lightning arresters, etc.
- > Temperature rise test:
 - Permanent three-phase up to 50 kA

High Voltage Laboratory

- > High voltage (3 test facilities):
 - Lightning & switching impulse: 2.7-1.6 MV/150kJ
 - Industrial frequency/DC:
 - 1,000 kV / 50/60 Hz;
 - 600 kV DC/30 mA
 - In rain, artificial pollution
 - DP, dielectric losses, RIV, noise, etc.

Cable Laboratory

- > AC or DC type tests
- > Long-term AC resistance
 - LV, MV, up to 90 kV
 - Long-term pre-qualification tests on buried loops
 - Thermo-mechanical tests
- > Long-term DC resistance
 - 1 MV DC test facility

SECTORS OF APPLICATION

Energy industry/Power distribution and transmission/Smart Grids/Research & Development

OUR OFFER

- Equipment qualification with preferential support conditions.
- Development of innovative solutions and operations to secure their integration into a complex electrical system.
- Testing of system integration and validation of "smart" solutions from downstream of the meter to the primary substation.
- Standardised or non-standard qualifications or sampling for specific operating conditions.
- Investigations following high-stake incidents, support in the development and validation of corrective solutions.
- Optimisation of asset management: extension of the range of application of equipment, prolongation of service lives.
- "Understanding and interpreting electrical equipment tests" training course. Ref. ARN3994.





EDF©Marc Caraveo

OUR STRENGTHS

- EDF Networks Lab offers a complete range of tests on a single site, covering all substation equipment and network connecting equipment from LV to 420 kV. The laboratory is accredited in accordance with the NF EN ISO/IEC 17025 (COFRAC) standard for a large part of its activity, notably in accordance with the IEC reference base, as well as network operator specifications.
- The laboratories are members of the STL (Short-circuit Testing Liaison).
- They have testing and logistics resources and accessories that enable the requirements of the particular specifications of French and European operators to be met.
- 75 highly qualified experts, engineers and test technicians who can rely on support from EDF's multidisciplinary R&D researchers, where necessary



Accreditation
no. 1-0120
Scope available
on www.cofrac.fr

THEY PUT THEIR TRUST IN US

Network operator: Despite the fact that sufficient statistical data was not available to determine the end-of-life criteria for a pool of oil circuit breakers (FVH), a targeted electrical and mechanic-climatic endurance test campaign on a sample of older devices enabled their technical service life to be extended by 5 to 10 years.

Cable manufacturers: Certified qualification of equipment for the 320 kV DC France-Spain and France-Italy links.

Manufacturer: Development of a specific test programme and performance of cut-off tests to support the development of an innovative HVDC circuit breaker.



EDF©Marc Caraveo

TO FIND OUT MORE...

- > [EDF Networks Lab](#)
- > [Validating your equipment in an experimental smart grid](#)
- > [High volume chambers](#)
- > [Testing and developing your batteries](#)

Issuing of a complete and documented test report

Studies
On quotation

Training
On quotation. Tailor-made.

Tests and measurements
By the day, on quotation

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STUDY AND EXPERTISE OF CABLE CONNECTIONS

YOUR CHALLENGES

- Identify and prevent failures of your electric power network
- Design, develop and adapt your electric power network by integrating the latest technological and environmental developments
- Implement monitoring and asset management solutions for your cable connections
- Assess the working condition of your equipment

*Study using COMSOL –
magnetic flux density*

SOME OF OUR EQUIPMENT

Modelling tools and software

> ULIS:

- Analytical modelling for thermal and electrical design of cables (Permissible Current Rating)
- Works for cables located in ventilated ducts (new)
- Calculation compliant with IEC 60287 and 60853

> COMSOL Multiphysics®:

- 3D modelling (FEM) of electrical, thermal and mechanical phenomena with strong or weak coupling

> EMTP RV:

- Analysis of electric power networks

> CST STUDIO SUITE – EFC 400:

- 3D electromagnetic modelling

> CDEGS:

- Analysis of ground networks and of current propagation in structures
- Low and high frequency EMC analysis

Test laboratories to conduct experimental validation to support modelling work

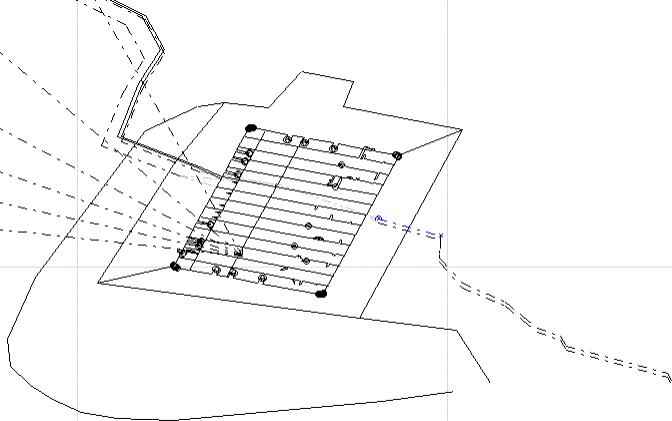
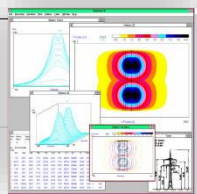
YOUR SECTOR

Industry / Transportation / Grid operator / Research & Development

OUR OFFER

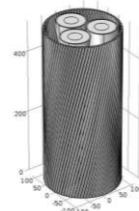
- Expertise of faulty or malfunctioning equipment, on site and in laboratory
- Specification of electrical equipment intended for new usage (offshore, PV, mobility, storage...)
- Development of asset management solutions
- Assessment of the working condition of connections and equipment
- Feasibility studies for network technologies development (new DC cables, MV and HV-DC connections)
- Cable diagnosis and connection monitoring: development of systems for data analysis
- Training course « Understanding and interpreting electrical equipment tests » (Ref. ARN3994)





OUR STRENGTHS

- 15 highly skilled engineers and researchers involved in the definition of methods and in the design of facilities for testing electrical cables
- A wide range of equipment expertise thanks to the complementarity with EDF R&D mechanics and materials laboratories
- More than 50 years of experience supporting the Transport System Operator and the Distribution System Operator in France



THEY HAVE CHOSEN US

Power grid operator in the Middle East: expertise of a 400kV underground cable following a breakdown of the main insulation and identification of failure causes of the secondary insulation on junctions.

Industrial client in energy sector: cable diagnosis in indoor facility following production shutdown. « ...we appreciate your very strong involvement given the particularly stringent deadlines. Thanks to your work we ruled out a failure due to the cables and therefore we avoided their unnecessary replacement... »

Train manufacturer: identification of failure causes on new cable connections. « Very good exchanges during the service. The sharing of expertise and of lessons learnt was very much appreciated. Report of very good quality. »



TO FIND OUT MORE...

- > [Power tests and high voltage tests](#)
- > [Guaranteeing the quality of electricity in your power network](#)
- > [EDF Power Networks Lab](#)

Studies

On quotation

Training courses

On quotation

Tailor-made training possible

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ENSURING THE RELIABILITY OF YOUR INDUSTRIAL POWER NETWORKS



EDF/THOMAS CHAUDONNET

YOUR CHALLENGES

- To design, approve and justify a network architecture with respect to a goal of supply continuity
- To determine a technical and economic optimum between various solutions to improve the reliability of an industrial power network
- To justify work programmes and the associated investments

OUR TOOLS

> **KB3** software suite: a set of software designed to automate and optimise the realisation of operational safety studies

> **K6** database (*CASSIS: Characterisation of the Power Supply of Systems through their Service Interruption Sequences* or *"Caractérisation de l'Alimentation des Systèmes par leurs Séquences d'Interruption de Service"* in French): Business line knowledge base that can be used on the **KB3** software suite, designed to model complex and dynamic electrical structures

> **AMETISTE** database (*Equipment Attributes for Reliability Studies of Electrical Systems* or *"Attributs des Matériels pour les ETudes de fiabilité des sySTèmes Electriques"* in French)

SECTORS OF APPLICATION

Designers and operators of industrial power networks that include the electrical substations of public transmission and distribution networks, internal power networks on industrial sites

OUR OFFER

- Estimation of the reliability, availability and weak points of a network by means of numerical simulation, using proven and dedicated software tools and data derived from our feedback (failure rate, duration of repairs, etc.)
- An approach that can be used in design, in support of an audit or to compare possible developments on a network
- Expert support in various study phases
- The possibility of further developing software tools, in order to enable the study of new specific power systems and extension to other energy networks





OUR STRENGTHS

- A mature approach, based on international standards and currently incorporated into the offers developed by EDF Group entities.
- More than 15 years' experience in the development of software tools (K6, [KB3](#)) for the EDF Group's internal entities. Continuous development of tools to enable the study of new power systems and extension to other energy networks.
- Internationally recognised scientific excellence (papers, awards, higher education).

THEY PUT THEIR TRUST IN US

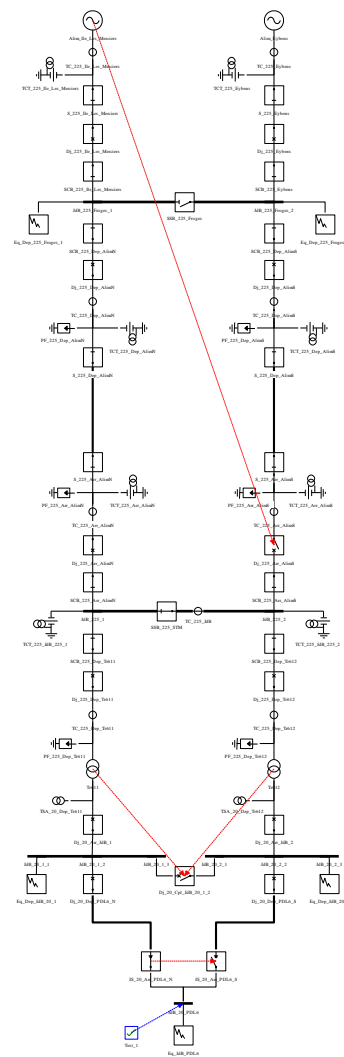
Data centre operator: Comparison of possible developments in the architecture of internal power distribution networks, in order to modernise and streamline them, while ensuring an acceptable level of reliability and availability in server power supply.

Major industrial site: Support in the design and estimation of the benefit of a voltage dip desensitisation solution, based on flywheel groups for an industrial production site

Designer of an offshore wind power site: Expertise in the design of the internal power network, which enabled the benefits of a remote control system to be demonstrated, in terms of reliability and availability.

TO FIND OUT MORE...

- > [Guaranteeing the quality of electricity in your power network](#)
- > [Guaranteeing the performance of your electric motors](#)
- > [Protecting your equipment against electrical transients](#)



Training
On quotation.

Studies
On quotation

Audits
On quotation

CONTACT

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PROTECTING YOUR EQUIPMENT AGAINST ELECTRICAL TRANSIENTS

YOUR CHALLENGES

- To check equipment resistance to overvoltage
- To analyse damage to equipment connected to a public or industrial network
- To size the insulation of electrical equipment during the design phase
- To approve a protection plan
- To quantify the consequences of lightning and operations

SOME OF OUR EQUIPMENT

➤ [EMTP software](#) (www.emtp-software.com)

> PAMLAB software, uncertainty estimates, parameter optimisation and input data impact analysis > Real-time simulation in HYPERSIM coupled with EMTP

SECTORS OF APPLICATION

Electrical engineering industry/Power electronics/Transmission and distribution networks/Integration of renewable energies into networks/Research & Development

OUR OFFER

- Sale of EMTP licences and additional options for uncertainty estimates, parameter optimisation and input data impact analysis (PAMLAB)
- Studies using these tools
- Expertise in insulation coordination
- Expertise in ferro-resonance
- Training in calculation tools (EMTP, PAMLAB)
- Theoretical training in electromagnetic transient phenomena



OUR STRENGTHS

- [EMTP](#) software sold to several thousands of users for over 20 years
- Internationally recognised know-how and expertise that has been tried and tested in the French power system
- Ability to adapt tools to your needs, since we control the software source code
- Internationally recognised scientific excellence (publications, awards, higher education)

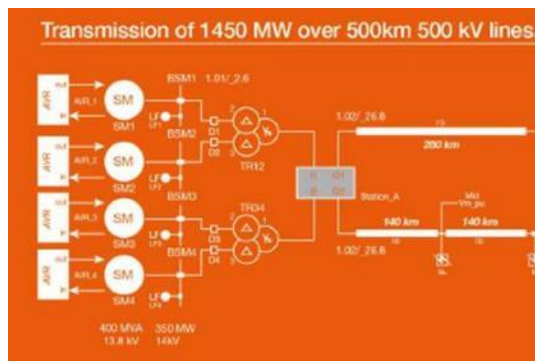
THEY PUT THEIR TRUST IN US

RTE: Prior to 2010, our team was historically in charge of coordinating the insulation of transmission networks.

ENGIE: Impact of electrical connections on gas pipelines and sizing of grounding.

EPR nuclear power plant projects: Sizing of grounding systems to protect against lightning.

Support for EDF's international projects: Sizing of networks and protection plans for international customers.



TO FIND OUT MORE...

- > [Guaranteeing the quality of electricity in your power network](#)
- > [Power tests and high voltage tests](#)

Training

Tailor-made training possible.

Tests and measurements

By the day, on quotation

Audits, Studies

On quotation

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TERRITORIES, HEATING AND COOLING NETWORKS

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SIMULATING TOMORROW'S SUSTAINABLE CITY



YOUR OBJECTIVES

- To create a liveable and attractive urban environment for all residents and attract investments
- To select and deploy cost-effective low carbon energy systems, energy efficient buildings, local renewables and smart grid technologies
- To optimize investments for sustainable objectives from the early stage of urban planning
- To improve urban planning decisions, by respecting links between energy, environmental quality and mobility needs

INNOVATIVE APPROACH

A unique approach, coupling:

- in-depth expertise in the low carbon energy solutions
- Systemic approach starting with energy and extended to mobility, quality air, noise, heat island effect for better quality of life
- Interactive simulation tools with 3D scenario of the city.

We optimize investments and operation costs from the early stage of urban planning to your renovation plans.

Taylor made for each city, to address unique objectives and cultural-social-built environment needs.

SECTORS OF APPLICATION

Municipalities, real estate developers, Urban Planning Departments, Housing Associations

Urban sectors: planning, development, construction, environment improvement, waste management, transport and land use planning.

OUR OFFER

- Consultancy for the definition of **Energy & Urban project objectives**, with visualization of data and indicators on a 3D scenario of the studied district or city.
- Assessment of **Energy concept scenarios**: definition of few scenarios for energy efficiency actions, renewables development and smart grids, with cost / benefits analysis.
- **Simulation tool for Energy concept scenarios**: energy demand, Renewable potential, networks capacities.
- **Systemic & integrative modelling decision making tool** with an interactive web-accessible 3D interface of your city / district. Includes energy system models (energy demand, renewable, networks) and can be extended to mobility, quality of air, noise, urban heat island as well as quality of life indicators.





OUR STRENGTHS

- A long lasting experience and scientific excellence in low carbon energy solutions for cities and regions
- A unique approach from planning to operations, with strong commitments
- A systemic approach, encompassing innovative energy systems and energy efficiency in buildings, renewables, smart grids, public lighting, low carbon mobility...

THEY PUT THEIR TRUST IN US

Singapore (2017): The Housing & Development Board has used our 3D tool to build their best investment in policies and technologies for more sustainable and liveable neighbourhoods

LINGANG, Shanghai (2014): An energy concept for a 42km² "green field" innovative green urban design proposal for the Shanghai Zhangjiang Development Company with China Investment Development. The concept cut CO₂ emissions by half, produced 100% of the district's energy locally and reduced the energy bill for residents by 10%.

Tegel, Berlin (2015): Visualization and assessment of different urban energy planning strategies by analysing the interrelation between planning decisions and multi-energy systems (integration of Renewable Energy Sources, Combined Heat & Power, Industrial Waste Heat, etc.).



"This is a sophisticated tool that will simulate complex urban scenarios and help HDB planners analyse and determine the best combination of strategies using both design and technological solutions. Ultimately, it will help us create a better living environment that will benefit our residents."
Dr Cheong Koon Hean, Chief Executive Officer of HDB

TO FIND OUT MORE...

- > [Urban planning platform](#)
- > [Empowering the future of your city](#) (brochure)
- > [EDF City Platform](#) (brochure)
- > [Citelum \(EDF Group\), Muse® the urban space management platform](#)

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IMPROVING YOUR HEAT DEMAND FORECASTS



EDF©Oliver Pirard

EDF Luminus cogeneration
motor, HAM

YOUR CHALLENGES

- To improve the reliability of your heat demand forecasts
- To optimise your heat production as accurately as possible
- To receive easy-to-use forecasts that are tailored to your needs

OUR TOOLS

- > The ForecastHeat software is among the most efficient short-term heat demand forecasting software on the market (source: Dalkia 2015 benchmark). Forecasts are based on your past production and local weather forecasts.

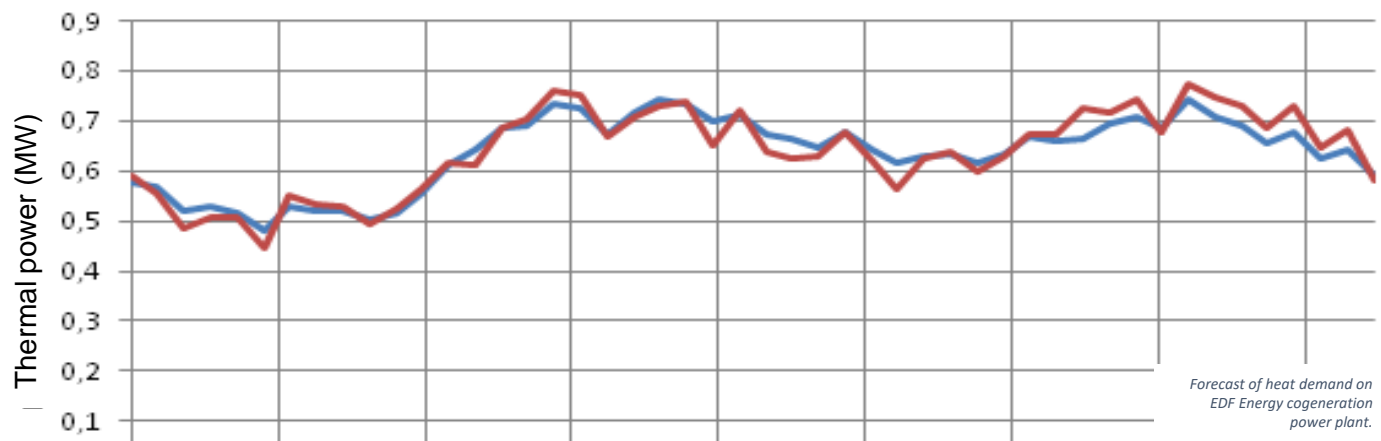
SECTORS OF APPLICATION

Utilities/Energy services/Industry/Facility management

OUR OFFER

- A service to forecast the heat demand on your production unit, based on our ForecastHeat software, in a format defined with you. The forecasting time scale and frequency are adapted to your needs and available data
- Support to optimise your production





OUR STRENGTHS

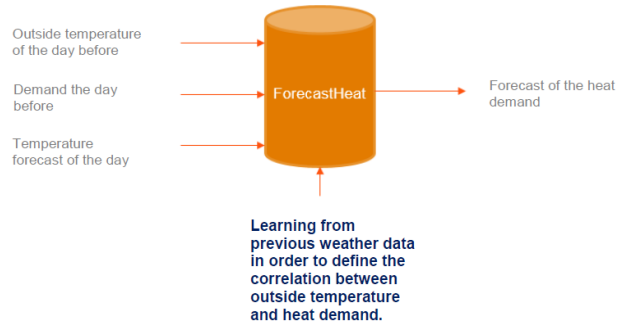
- One software for your entire plant pool: ForecastHeat is extremely efficient, regardless of the climate.
- You benefit from EDF feedback: the software has been developed with operators and validated on several EDF group installations of very different sizes.
- Cutting-edge software developed by EDF R&D: ForecastHeat combines several statistical methods and is regularly improved to incorporate new forecasting techniques

THEY PUT THEIR TRUST IN US

EDF Polska: User of ForecastHeat since 2013 in several power plants (20% improvement in accuracy).

Dalkia France: Selection of ForecastHeat after the benchmarking of four tools in 2015. Deployment planned in 400 boiler rooms.

Dalkia UK/EDF Energy: Assessment of ForecastHeat in a London power plant. Estimated financial gain of 6% in combination with the PILOT heating network optimisation software. Deployment planned for 2017.



TO FIND OUT MORE...

- > [Testing the performance of your thermo-dynamic equipment](#)
- > [Planning your operations more efficiently through innovative methods](#)
- > [Dalkia \(EDF Group\), leader in energy services](#)

Forecasting service
On quotation

Studies
On quotation

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INTEGRATE RENEWABLE ENERGY IN THE REAL-TIME MANAGEMENT OF YOUR ELECTRIC POWER NETWORK

YOUR CHALLENGES

- Adapt the dynamic operations of your electric power network (ranging from small island networks to large interconnected networks) to the increasing penetration of variable and non-synchronous renewable energy (solar & wind)
- Maintain the stability and reliability of the system with high shares of variable renewable energy
- Assess the current limits of variable renewable energy penetration in your network and find solutions to increase them
- Operate equipment like batteries or variable renewable energy to provide ancillary services

OUR TOOLS

> Paladyn: for simulating the frequency behaviour of a large electric power network

> Dynamo: for setting up a production plan with the highest share of variable renewable energy

> Opium: for assessing the allowable margins of an electric power network (J-1, h-2, h-1, <15min) that comply with a given risk criteria, taking into account the production uncertainty due to variable renewable energy

> Commercial software Eurostag, EMTP-RV and Power Factory: modelling, simulation and analysis of electric power networks

YOUR SECTOR

Designers and operators of electric power networks, of stationary storage equipment, of electric power plant / Local authorities / Engineering and consulting firms

OUR OFFER

- Analysis of the maximum penetration levels of variable renewable energy in an electric power network and identification of associated constraints
- Simulation of the frequency behaviour of an electric power network under various scenarios
- Assistance to the identification of the best technical and economic solutions
- Assistance to the implementation of innovative solutions (e.g. frequency control mechanisms, control of batteries and variable renewable energy)





OUR STRENGTHS

- An internationally recognised scientific excellence (papers, awards, graduate training, European projects)
- A extensive experience ranging from large interconnected networks (European power system) to microgrids
- Unique modelling and simulation tools, constantly improved and benchmarked to real measurements and frequent exchanges with various stakeholders of electric power systems (from system operators to equipment suppliers and electricity producers)

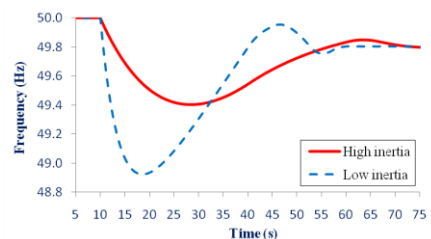
THEY HAVE CHOSEN US

Island power system operators: assistance to the definition of the maximum penetration levels of variable renewable energy, identification of solutions to increase them (e.g. storage) and assistance during implementation

EDF Renouvelables (2017-2018): supply and assistance during implementation of control algorithms of variable renewable energy and storage assets (including batteries) on various sites

EDF SA (2016): “Technical and economic analysis of the European electric power system with 60% renewable energy” study, which received the “UVIG Annual Achievement Award”

European project EU-SysFlex (2017-2021): identification of a long-term roadmap to facilitate the large-scale integration of renewable energy across Europe, practical assistance to power system operators



VENTEEA project (2014-2016): collaborative project on smart grid potential to integrate a high share of wind power capacity in a rural network

TO FIND OUT MORE...

- > [Testing and developing your batteries](#)
- > Training course “Insertion of renewable energies” » [\(ARN4011\)](#)

Training courses

On quotation
Tailor-made training possible

Studies

On quotation

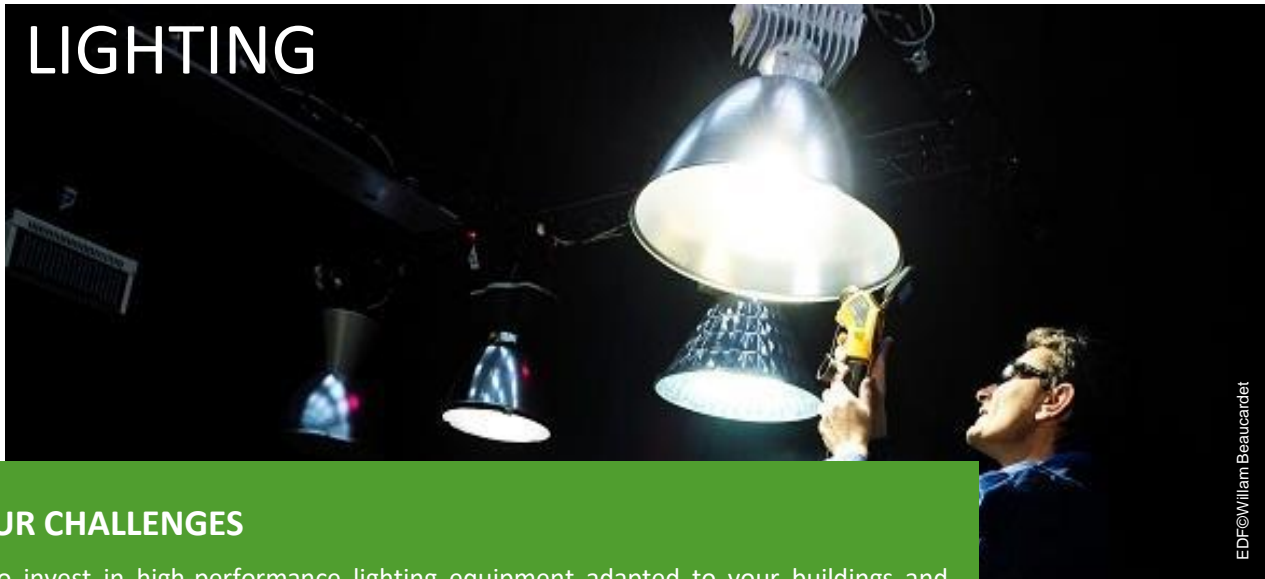
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TESTING AND OPTIMISING YOUR LIGHTING



EDF©William Beaucardet

YOUR CHALLENGES

- To invest in high-performance lighting equipment adapted to your buildings and outdoor spaces, which includes the latest technologies.
- To guarantee the quality of equipment.
- To control your installation in accordance with all your needs.
- To come up with smart, communicating solutions.

SOME OF OUR EQUIPMENT

- > Spectrometer
- > Photogoniometer
- > Infra-red camera
- > Network analyser

SECTORS OF APPLICATION

Sectors of application: Industry / Tertiary sector / Public lighting

Targeted equipment: Lamps, lights, ballasts, management and control computer systems

OUR OFFER

- Support and assistance in decision-making for your lighting solutions: identification of needs and drafting of specifications.
- Equipment tests: assessment of lighting solutions through the appraisal of the multiple innovations presented (quality of manufacture, quality of components, choice of design, resistance over time).
- Support in the implementation and maintenance conditions necessary to ensure satisfactory operation.
- Co-development of solutions that incorporate smart lighting.





OUR STRENGTHS

- Multidisciplinary expertise directly available: electrical, electronic, thermal, equipment, communication and control
- Recognised experience and know-how implemented by our technicians and expert engineers
- A single laboratory to test all components (*possibility of carrying out tests in cold chambers*)
- An outdoor public lighting platform for network tests
- A laboratory accessible to customers

THEY PUT THEIR TRUST IN US

Logistics operator (2016): Equipment tests before making investment decisions.

Railway transportation (2015): Drafting of specifications for station platform lighting.

Private car park operator (2015): Support in investment-related decision-making (technological choices and implementation recommendations).

Agri-food / Aeronautics: Analysis of specific needs and assessment of equipment to support the choice of solutions.



TO FIND OUT MORE...

- > [Innovating with and for you through design](#)
- > [Simulating tomorrow's sustainable city](#)
- > [Citelum \(EDF Group\), the reference for city lighting](#)

Tests and measurements
On quotation

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DESIGNING SERVICES FOR VULNERABLE POPULATIONS IN YOUR TERRITORY



YOUR CHALLENGES

- To propose innovative solutions to energy poverty, by promoting cross-sectorial approaches (lifestyle of residents, energy, building, environment, living in harmony, etc.)
- To develop a business model suited to your case, by identifying and characterising local partners and their needs (constituents, social landlords, tenants, businesses, etc.)
- To optimise your project, by involving the target population during each study and development phase

YOUR SECTOR

Social landlords, companies or communities with a social project

SOME OF OUR TOOLS AND METHODS

- Design methods in frugal innovation
- Qualitative studies (focus groups, individual interviews, workshop events)
- Tools for measuring the impact of energy solutions for landlords
- Quantitative studies
- Business Model Canvas



Toulouse solidarity workshop: "a workshop in my district where I am trained and informed, in order to re-appropriate my home and reduce my bills"

OUR OFFER

A team of experts assists you in the development of your energy poverty-related social project:

- Identification and prioritisation of the essential requirements of vulnerable populations (upstream studies involving complementary disciplines in sociology, ethnography, economics, statistics, etc.)
- Provision of an optimal response and advice on social financing (reaching to local public and private partners)
- Co-development of the business model of the chosen solution and proposal of economic models and innovative partnerships
- Improvement of the acceptability of the project target and its implementation (involvement of the project target populations at each stage of development)





Renovation of the Clichy sous Bois co-ownership building: guidance for households

OUR STRENGTHS

- A multidisciplinary team with expertise in business models, sociology, ergonomics, design and statistics
- A network of partner companies committed to vulnerable populations: Veolia, Renault, Bouygues, Leroy Merlin, etc.
- Partnerships with Ashoka and the HEC Master's Degree in Sustainability & Social Innovation, Social and Business Action Tank

THEY HAVE CHOSEN US

Toulouse Métropole (since 2013):

Setting up of the first "Solidarity Workshop" in collaboration with all the stakeholders: residents of the Empalot district, Habitat Toulouse, City of Toulouse, CAF, Leroy Merlin, Compagnons Bâisseurs ("Master Builders") (watch the [video](#) – in French)

Brézillon - Bouygues Group (since 2014): Guidance for the people during a renovation programme experiment of a multi-family building in bad conditions

Vilogia (since 2016):

Setting up a solidarity workshop for the tenants of its property portfolio in the city of Hem (59)

EDF - Sales Division (since 2016):

Design and implementation of a solution for the display of electricity consumption for customers in vulnerable situations



The Solidarity Workshop was awarded the 1st eco-mayor prize in 2016.



Inauguration of the Toulouse Solidarity Workshop in June 2015



Low-tech thermometer



Energy budget management application designed for vulnerable populations

TO FIND OUT MORE...

- > [Interpreting your customers' energy consumption](#)
- > [Anticipating societal changes and their impact on your activities](#)

Tailor-made studies
On quotation

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IMPROVING AIR QUALITY



Your challenges

- Visualize air quality in an urban context
- Measure and describe major pollutant in an urban area
- Inspire practical suggestion for air quality improvement
- Raise awareness on air quality issues or build an innovation programme on air quality

OUR EQUIPEMENTS

- > 3D visualization of air quality
- > Analysis and post-treatment of air quality data
- > Collection of data via low costs approach and measuring campaign

SECTORS OF APPLICATION

Urban development, smart city management

OUR OFFER

- 3D simulation of atmospheric pollutant dispersion and chemistry
- Consultancy on low cost air quality measure
- Delivery of data collection campaign
- Backtrack and identification of pollutant emissions
- Training and educational programme on air quality issue





OUR STRENGTH

- Several decades of experience in industrial and urban EDF site.
- Strong links with top academic partner (common lab with the Ecole des Ponts ParisTech).
- High level recognition in sciences and academic (publications, distinctions, university education).
- Long term training experience for an high spectrum of public from engineers to general public
- Home made development of adapted tools

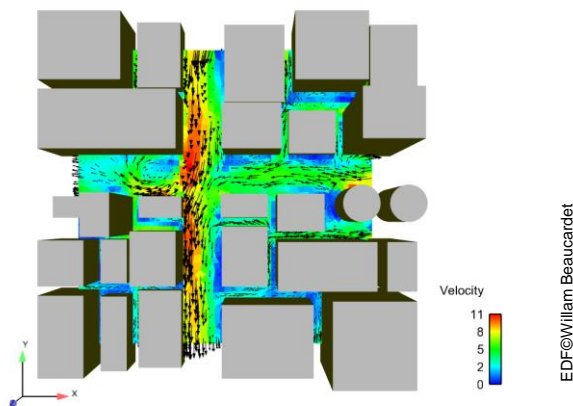
THEY PUT THEIR TRUST IN US

Grand Paris (2019) : 3D visualization of air quality for a new urban area in Villiers sur Marne (Grand Paris Area) for the urban highway A4 toward the buildings

EDF : dispersion of NO, NO2 et ozone including chemistry modelling for industrial sites.

ADEME (2019) : review on the real efficacy of air quality improvement measures linked to traffic regulation in Europe

Village Olympique Paris 2024 (2020) : 3D visualization of air quality for the Olympic Games village in Paris from the urban highway A86 toward the buildings



TO FIND OUT MORE

- > Modelling industrial emissions dispersion
- > Design optimal and comfortable ventilation for the building
- > Imagine the smart et the wise cities

Training

On quotation. Tailor-made training possible.

Audits

On quotation.

Studies

On quotation

Tests and measurements

By the day, on quotation

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INDUSTRIAL, MECHANICAL, MATERIAL EXPERTISE

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HIGH VOLUME CHAMBERS



EDF©Philippe Eranian

Test in ice
Climatic chamber
EDF Lab Renardières

YOUR CHALLENGES

- To characterise and approve equipment, an industrial product or a large-scale integrated solution in an extreme environment.
- To have a solution enabling the simulation of accelerated ageing on bulky equipment.
- To objectify the real service life and endurance of equipment in high and low temperatures or under climatic ageing constraints.
- To check the behaviour of equipment subjected to electromagnetic fields.

SOME OF OUR EQUIPMENT

> Climatic chamber:

1,200 m³ -40°C / +60°C /
Solar radiation
Humidity
Ice

> Accelerated ageing chamber:

675 m³ 60 kV / 170 kV 50 Hz
Moist heat
Solar radiation
Salt mist

> Martigues substation:

Natural pollution in severe
marine and industrial condition

SECTORS OF APPLICATION

Transport industry/Specialised vehicles/Armaments industry/Construction
industry/Electric vehicles/Offshore/Research & Development

OUR OFFER

- Environmental constraint tests (climatic constraints, lightning, electromagnetic compatibility-EMC) with one of the largest climatic chambers in Europe and its various EMC chambers.
- Extensive, "tailor-made" tests of exposure to pollution or severe climates, in a natural environment or in a test chamber, or controlled lightning strikes.
- Electromagnetic compatibility tests using its two chambers (anechoic and reverberation) for both emissions and immunity.
- The laboratory is also equipped with generators enabling most immunity tests to be carried out (electrostatic discharges, shock waves, fast transients in bursts, radio frequencies, etc.).



OUR STRENGTHS

- A climatic chamber of exceptional size
- EDF Networks Lab offers a complete range of tests on a single site, covering all substation equipment and network connecting equipment from LV to 420 kV. The laboratory is accredited in accordance with the NF EN ISO/IEC 17025 (COFRAC) standard for a large part of its activity, notably in accordance with the IEC reference base, as well as network operator specifications.
- 75 highly qualified experts, engineers and test technicians who can rely on support from EDF's multidisciplinary R&D researchers, where necessary.



Accreditation
no. 1-0120
Scope available
on www.cofrac.fr

THEY PUT THEIR TRUST IN US

Armaments industry: Tests of the proper operation of military or public works equipment under extreme climatic constraints: proper operation in extreme temperatures, in ice, after positive and negative thermal shocks, exposure to solar radiation or humid atmospheres (90 to 95%).

Vehicle manufacturer: Testing of electric vehicles in extreme temperature conditions with respect to the safety and proper operation of batteries.



TO FIND OUT MORE...

- > [EDF Networks Lab](#)
- > [Power tests and high voltage tests](#)
- > [Testing and developing your batteries](#)
- > [Validating your equipment in an experimental smart grid](#)

Issuing of a
complete and documented
test report

Studies
On quotation

Tests and measurements
By the day, on quotation

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TESTING YOUR EQUIPMENT SUBJECTED TO VIBRATIONS



CDR

YOUR CHALLENGES

- To control the vibratory behaviour of your industrial equipment that is subjected to multiple mechanical excitation
- To optimise vibration reduction solutions
- To carry out experimental validation of prototypes
- To carry out experimental validation of digital models

EVADYN test bench
on the EDF Lab Paris-
Saclay site.

SOME OF OUR EQUIPMENT

> EVADYN pad (42t): 4mx4m
isolated from Civil Engineering (cut-
off frequency: 2.5Hz)

> LMS acquisition platform (up to
180 channels when multiple
digitisers are linked)

> DSpace real-time micro-controller
(16 inputs + 6 outputs)

> Shaker units from 10N to 30KN

> 140 mono-axis charge
accelerometers

> 110 ICP triple-axis accelerometers

> Laser vibrometer

SECTORS OF APPLICATION

Industrial structures subjected to vibratory excitation in the energy and transport sectors (automotive, aeronautical, railway, maritime)

OUR OFFER

- Performance of vibration tests on industrial installation structures and equipment:
 - Equipment/structures weighing several tonnes
 - Multiple excitation points (shock hammers, shaker units)
 - Variety of sensors (laser velocimeter, accelerometers, gauges, etc.)
 - Large number of measuring channels (>200)
- Analysis/use of data
 - Modal analysis
 - Measurements during operation (ODS)
- Post-processing in relation with digital models
 - Correlation of calculations/tests
 - Recalibration of models, etc.





OUR STRENGTHS

- Experimental know-how proven through numerous test campaigns on our production sites
- Expertise in both digital and experimental vibration diagnosis, currently used to ensure the availability of EDF equipment
- Internationally recognised scientific excellence (publications, awards, higher education) in support of studies by EDF's engineering division

THEY PUT THEIR TRUST IN US

EDF Nuclear:

- Active monitoring and hybrid tests on steam generator tubes (2015)
- Characterisation of the non-linear stiffness of the spring-dimple assemblies in a fuel assembly grid/correlation of calculations/tests and digital recalibration (2011)
- Study of the stiffness of fuel assembly grids on impact (2010)

EDF Hydroelectricity:

- Vibratory behaviour of an arch dam in ambient noise (2015)

TO FIND OUT MORE...

- > [Controlling the availability of your rotating machines](#)
- > [In-depth control of your mechanical simulations](#)



Expertise, Studies
On quotation

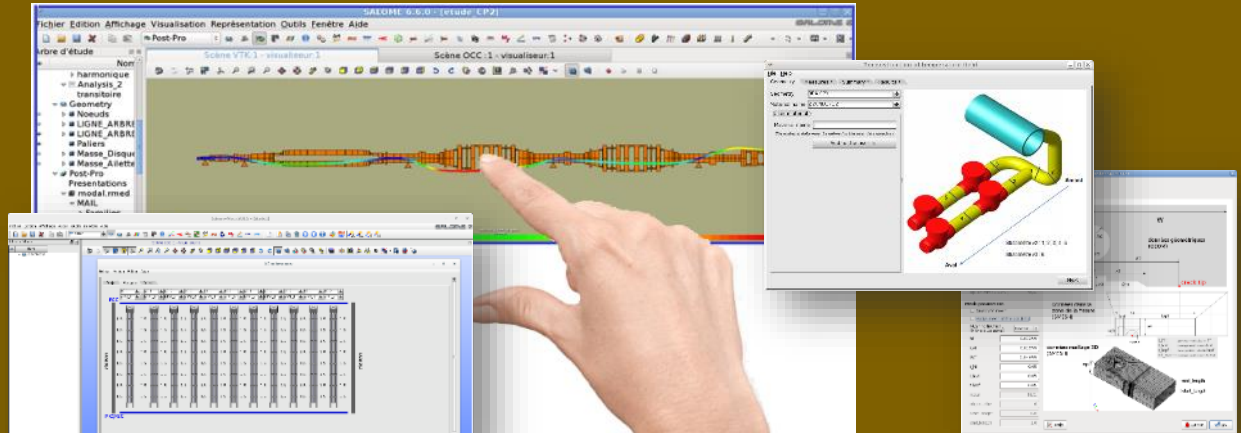
Tests and measurements
By the day, on quotation

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IN-DEPTH CONTROL OF YOUR MECHANICAL SIMULATIONS



Screenshots of "application" tools already available in Salome_Meca

YOUR CHALLENGES

- To reduce design and maintenance costs
- To better design structures through numerical simulation
- To obtain a rapid diagnosis of the behaviour of installations
- To democratise numerical simulation for you and your customers
- To improve performance in the support of your customers
- To optimise expenditure on code licences

THE TOOLS WE ARE DEVELOPING

> **Code_Aster:** Thermo-mechanical solver distributed under Open Source licence

400 types of finite element

100 behaviour laws

Complete manuals under quality warranty

Multi-physical

Multi-scale

Parallel computation

> **Salome-Meca:** Simulation platform with data pre-processing and post-processing modules

> "Application" tools based on Code_Aster/Salome-Meca

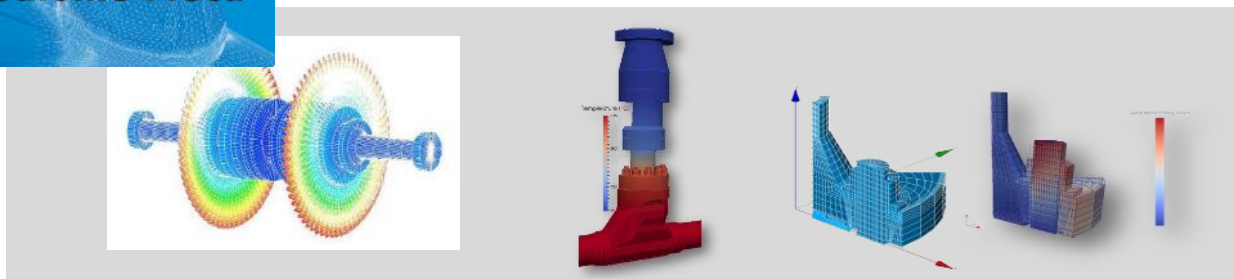
SECTORS OF APPLICATION

Industrial installation manufacturers and operators, design offices, industrial engineering and computing consulting companies

OUR OFFER

- Analysis of your mechanical simulation needs
- Design and development of "business line" application tools suited to your use cases
- Expertise for the optimised installation of tools on computing clusters
- Training in use for your participants and hotline during tool operation
- Simulation solutions with no licence fees





OUR STRENGTHS

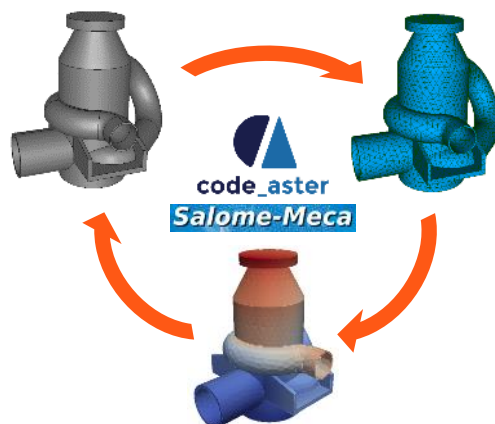
- Unique know-how acquired by our team over more than 30 years of code development
- A comprehensive simulation solution that can be adapted to specific applications
- A parallel thermo-mechanical solver with no licence fees
- A simulation tool qualified by the French and British nuclear safety authorities
- Tailor-made training courses

THEY PUT THEIR TRUST IN US

EDF: Code_Aster/Salome-Meca is the benchmark tool for mechanical simulation studies in the nuclear, hydroelectricity, thermal and wind power fields, carried out by more than 275 internal users.

Large companies, small and medium-sized companies and academics: Manufacturers such as ROLEX, LafargeHolcim, Valeo, Bouygues, Egis, Tractebel, AndritzHydro and many others use our tools for their numerical simulation studies. The ProNet Aster association includes 64 organisations from 12 countries.

Thousands of users around the world: The 2015 version of Code_Aster/Salome_Meca has been downloaded more than 8,000 times, and more than 1,100 external users are active in the forum.



TO FIND OUT MORE...

- > [Controlling the availability of your rotating machines](#)
- > [Testing your equipment subjected to vibrations](#)

- > Analysis of your needs
- > Studies
- > Training courses
- > Specific development of business line tools

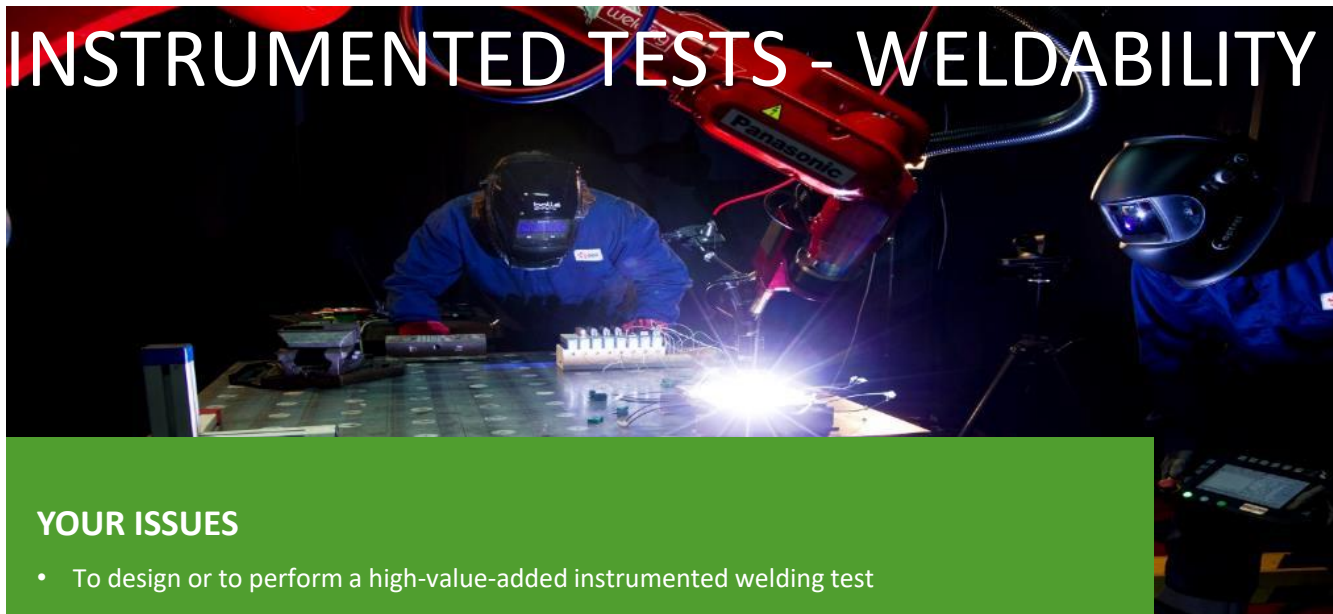
On quotation

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WELDING: DESIGN OF INSTRUMENTED TESTS - WELDABILITY



TIG welding test, EDF Lab Chatou site.

YOUR ISSUES

- To design or to perform a high-value-added instrumented welding test
- To use various high performance measurement systems
- To design and/or create plastic or metallic mock-ups
- To study the thermomechanical and thermo-hydraulic phenomena of TIG (Tungsten Inert Gas) welding

OUR EQUIPMENT

- > PANASONIC 350A welding robot
- > Lloyd Instruments 100kN traction machine
- > Photron 12,000 images/s rapid camera
- > FLIR 300° C – 3,500° C thermal camera
- > 20° C – 2,300° C precise thermocouples
- > Stereo-correlation of VIC3D images
- > Acoustic sensors
- > Milling machine
- > 260x260mm bandsaw
- > Disk saw Ø80mm, L 140mm
- > Digital milling machine 2.5 axes, max dimensions: X=1,035 Y=560 Z=510 mm
- > Digital tower Ø210x450mm between points
- > Code_Saturne (thermo-hydraulics)
- > Code_Aster (thermomechanics)
- > Solidworks CAD software

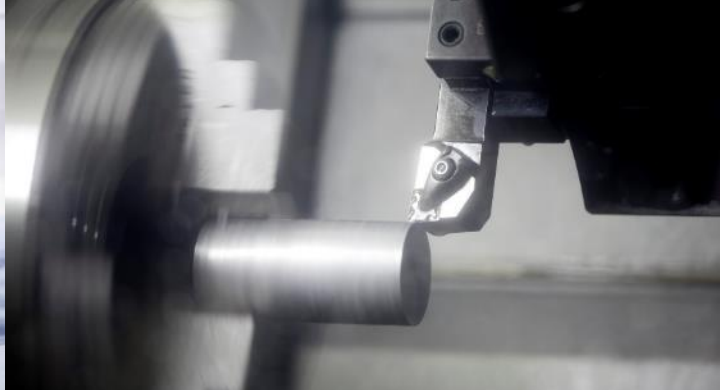
SECTORS OF APPLICATION

Boiler manufacturing / Piping / Energy / Aeronautics / Transportation / Petrochemical industry / Mechanics / Engineering / Research & Development

OUR OFFER

- Trial and test campaigns in the field of welding, either under external mechanical stress (traction) or not;
 - *Use of high-performance temperature measurement systems, mechanical deformations, fast infrared imaging, emission and acoustic emission spectroscopy (see the information on our equipment on the left)*
- Design and on-site machining of metal parts (milling, turning, cutting);
- Modelling studies and expertise in TIG welding (in the thermomechanical and thermo-hydraulic fields).





OUR STRENGTHS

- Numerous multi-disciplinary studies on TIG welding, covering thermomechanical and thermo-hydraulic aspects;
- Strong connection with our experimental team;
- Several advanced instrumentation devices;
- A very complete machine shop;
- Internationally recognised scientific excellence (papers, patents, partnerships).

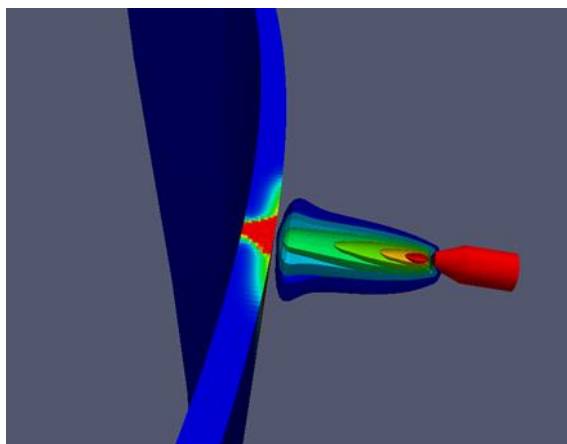
THEY PUT THEIR TRUST IN US

EDF Nuclear: Simulations of various maintenance operations in the nuclear plant pool, involving TIG welding, in order to improve process control and to provide [the Nuclear Safety Authority](#) with justifications for extending the service life of power plants.

EDF R&D: Machining of models (steel, stainless steel, aluminium, plexiglass, etc.) for various EDF R&D laboratories.

NeT Network ([Neutron Techniques Standardization for Structural Integrity](#)): Performance of simulations and tests on models (machined on site) dedicated to the study of mechanical stress during welding.

CEA and AREVA: Development of joint studies and tests on TIG welding ("[Modelling and Digital Simulation of Welding](#)" project).



TO FIND OUT MORE...

- > [In-depth control of your mechanical simulations](#)
- > [Ultrasonic inspection of your complex material](#)

- ✓ Tests and measurements
- ✓ Machining
- ✓ Studies and expertise

On quotation

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VALIDATING YOUR TEST SYSTEMS USING EDDY CURRENTS



EDF©Aldo Sperber

YOUR CHALLENGES

- To improve the manufacturing quality of high-performance metallic tubes
- To demonstrate the performance of non-destructive tests on metallic tubes
- To reduce costs by using numerical simulation for this demonstration

OUR TOOLS

- > Finite element software dedicated to the assessment of the behaviour of eddy current probes (C3D-CND), developed by EDF R&D
- > Laboratory for measuring eddy currents and the electromagnetic properties of materials

SECTORS OF APPLICATION

Steel industry/Nuclear industry/High-end metallic tubes (steel, inconel, brass)/Research & development

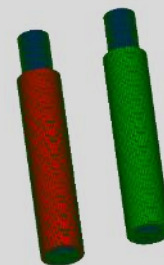
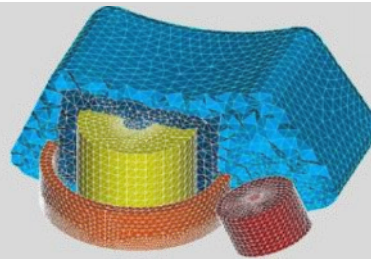
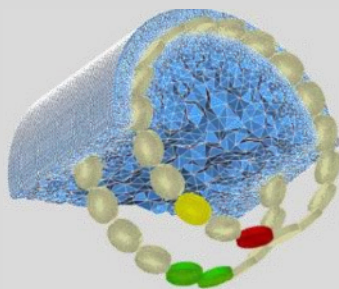
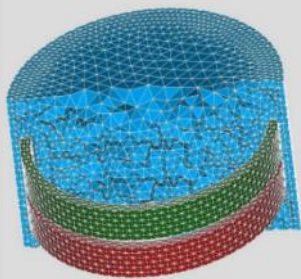
Application developed for nuclear power plant steam generator tubes, but which may concern all types of metallic tube requiring high-quality manufacturing control or operational analysis

OUR OFFER

Around our eddy current probe behaviour assessment software, we propose:

- C3D-CND software licences
- Training in the use of C3D-CND software
- Support in implementation, studies, audits
- Laboratory tests/measurements





OUR STRENGTHS

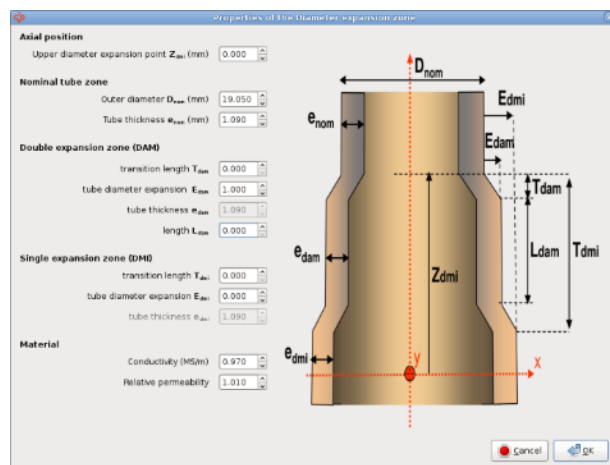
- Finite element calculation method
- Simple, easy-to-use graphical interface
- C3D-CND functions on Linux systems and on clusters, where necessary
- Probabilistic approach

THEY PUT THEIR TRUST IN US

EDF nuclear plant pool:

Quantification of the effects of copper deposits.

Modelling of axial or rotating probes for testing from the inside of a tube. Our C3D-CND software is currently used for EDF's needs to test the performance of the probes used in steam generator tube tests. It enables the behaviour of these probes to be assessed in the following cases: standard fault (axial/longitudinal, notches, holes, diameter variations), tube support elements, detection of possible deposits.



EPRI (USA): Software being tested at the Electric Power Research Institute (US nuclear operator R&D organisation).

TO FIND OUT MORE...

> [Ultrasound testing of your complex equipment](#)

Training

Tailor-made training possible.

Tests and measurements

By the day, on quotation

Audits, studies

On quotation

CONTACT

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ULTRASOUND TESTING OF YOUR COMPLEX EQUIPMENT



YOUR CHALLENGES

- To assess the performance of ultrasonic non-destructive testing on a metallic component with a complex structure
- To link the microstructural characteristics and the test performance
- To model ultrasonic tests based on a detailed characterisation of the structure
- To implement advanced experimental techniques

SOME OF OUR EQUIPMENT

- > Robotic test benches for automated tests: contact and immersion
- > 64 and 128-channel multi-element acquisition systems
- > Thickness gauge and manual scanner
- > Simulation computer codes:
 - Finite element code: ATHENA 2D & 3D (EDF)
 - Semi-analytical code: CIVA (CEA)
 - Hybrid code: CIVA/ATHENA 2D
- > Calculator:
 - 1.4 Tflops, 1.1 To RAM

SECTORS OF APPLICATION

Nuclear industry

Mechanical, aeronautics and transport industries

Oil industry

OUR OFFER

- Test campaign on representative models
- Test modelling study with advanced software
- Characterisation of the material data essential to the modelling of ultrasonic testing, based on the analysis resources available in our metallurgical assessment laboratory
- Development of experimental and digital study programmes, implementing the methodology developed at EDF R&D





OUR STRENGTHS

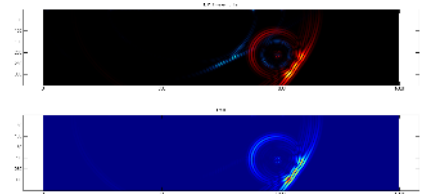
- Understanding of the physical phenomena of ultrasonic testing
- Support in the qualification of ultrasonic testing processes for the nuclear industry
- Implementation of leading ultrasonic non-destructive testing software, which has been qualified in the nuclear field
- Expertise in the field of the impact of the metallurgical structure on test performances
- Metallurgical assessment and structure characterisation resources available
- Development of innovative testing techniques
- (Metallic) *materials* database for modelling

THEY PUT THEIR TRUST IN US

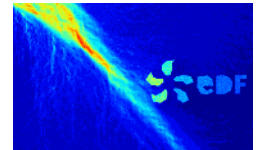
ONET (2016): Simulation of thickness loss tests under pipe retainers

The Welding Institute UK (2015): Simulation of ultrasonic tests on austenitic stainless steel welds

DCNS/EXTENDE/CEA (2014): Collaboration in the context of the ANR MOSAICS project to approve simulation codes for the testing of austenitic stainless steel welds



Test on model with calibrated fault



Finite element simulation of an ultrasound beam in a fictitious part with a complex structure

TO FIND OUT MORE...

> [Validating your test systems using eddy currents](#)

Studies
On quotation

Tests and measurements
By the day, on quotation

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CONTROLLING THE AVAILABILITY OF YOUR ROTATING MACHINES

YOUR CHALLENGES

In the field of industrial engineering:

- To reduce maintenance costs for turbines, compressors, pumps and motors
- To improve the availability and reliability of these rotating machines
- To test innovative balancing solutions
- To control the safe operation of machines under degraded conditions
- To predict the behaviour of support devices

In the field of research and development:

- To master the methods and tools used to calculate the dynamic behaviour of rotating machines
- To test and develop non-intrusive measurement methods

EUROPE test bench, EDF Lab
Paris Saclay

EDF©ALIX WILLIAM

SOME OF OUR EQUIPMENT

- > Programmable instrumentation and control (Labview)
- > Vane, contact, cracking configurations
- > Vibration sensors
- > Bearing temperature sensors
- > Vibration measurement system for vanes in operation
- > LMS acquisition and HGL storage system

SECTORS OF APPLICATION

Industry in the energy, transport, oil and gas and chemical sectors: to control the dynamic behaviour of turbine shaft lines, compressors, pumps and motors.

OUR OFFER

Depending on your needs, a programme that includes:

- Studies and assessments
- Experimental campaigns

For this, we rely on a test facility that is unique in Europe, enabling the vibration behaviour of large rotating machine shaft lines to be studied. The modular and scalable design of the test bench enables us to reproduce the phenomena observed on machines, in order to validate physical and digital models and test technological solutions and measurement methods for rotating machines.





OUR STRENGTHS

- Expertise in the shaft line dynamics, lubrication and metrology of rotating machines.
- Know-how proven through the industrial studies carried out for EDF's power generation assets for 30 years.
- Modular, large-scale test bench configuration that is unique in Europe (EUROPE test bench): the 40-tonne concrete mass positioned on spring-loaded boxes supports a 10-tonne metal frame 10 m in length, enabling the motor (66kW variable speed from 0 to 3,000rpm) and bearings to be positioned. The shaft line is made up of several parts, with a total length of 3.2 m. It is supported by two hydraulic bearings. The test bench can be extended up to 10m for a 3-bearing configuration and three couplings.
- An adaptive configuration: new test bench designs may be considered to adapt to other issues related to shaft line dynamic studies.

STUDIES CARRIED OUT:

- Impact of a crack on the vibratory behaviour of a rotor (2004)
- Test of an active balancing method (2007)
- Study of rotor-stator contact in the event of vane loss (2008)
- Development of a method used to measure the vibration of contactless vanes (BVM) in order to detect the origin of a cracking problem on the terminal vanes and to propose an adequate solution



TO FIND OUT MORE...

> [In-depth control of your mechanical simulations](#)

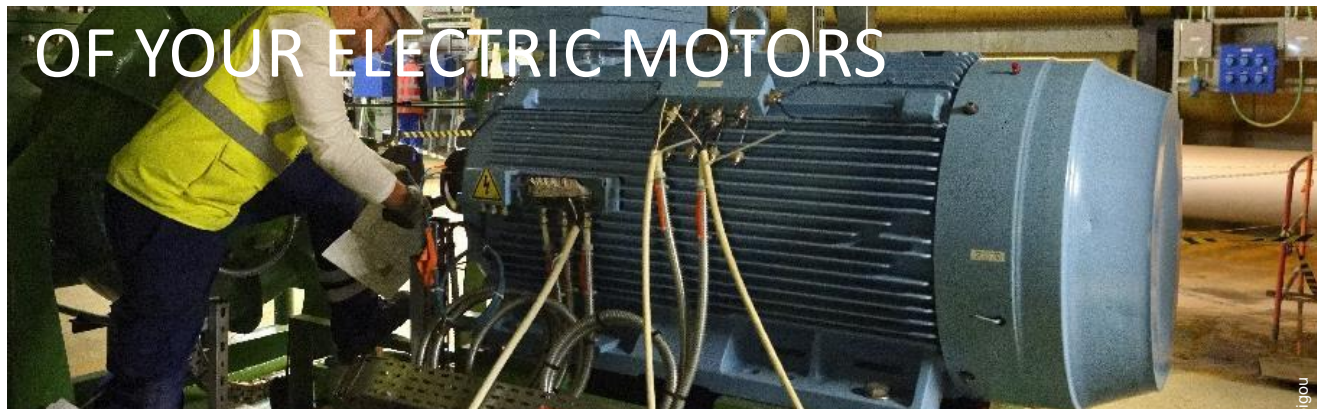
The cost of an experimental campaign depends on the modifications to be planned on the test bench and the period during which the test bench is made available.

Each study will result in a specific quote.

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GUARANTEERING THE PERFORMANCE OF YOUR ELECTRIC MOTORS



YOUR CHALLENGES

- To improve the predictive maintenance of electric motors: by measuring temperatures, vibration levels, load profiles and temperature and thus to detect internal machine faults early on.
- To improve industrial process monitoring: using highly economical instrumentation, information is sent from each motor and can trigger alarms on demand.
- To improve the energy efficiency of the process: depending on your load profile, the software offers you an economical solution and calculates your rate of return on investment.

OUR TOOLS

MotorBox system, made up of:

> A wireless sensor fitted on each motor in less than one minute

> A hub that collects data and automatically sends it back to a secure server

> Software designed by EDF R&D that assists in data processing

SECTORS OF APPLICATION

Food Industry/Chemical and plastics industries/Ventilation/Grinding/Compressed air/Traction/Lifting

OUR OFFER

Based on the MotorBox system, an innovative system designed by EDF R&D that facilitates the monitoring of electric motors for maintenance, process monitoring and energy efficiency purposes, we offer:

- Trial and test campaigns in the field of motor energy performance in all industrial processes
- Expert audits on site
- Assistance in industrial motorisation asset management
- Assistance in project design and construction supervision to implement solutions to optimise your motors' consumption
- Training in investment decisions for more economical motorisation solutions





©DR

OUR STRENGTHS

- An energy self-sufficient "plug and play" solution, which is extremely simple to install and use
- Decades of know-how and expertise in the field of motors incorporated into the software
- Universal solution that can be adapted to any type of low voltage motor

THEY PUT THEIR TRUST IN US

EDF (2015): Used with our customers to offer energy-saving solutions..

EDF Energy (2015): Successfully tested with EDF ENERGY UK customers in 2015.



TO FIND OUT MORE...

- > [Testing your rotating machines in disrupted environments](#)
- > [MotorBox on EDF YouTube channel](#) *(in French)*

MotorBox system
Diagnostic service
Audit, Appraisal
Training and assistance

On quotation

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VALIDATING THE DESIGN AND RECEPTION OF TRANSFORMERS



YOUR CHALLENGES

- Verify the conformity of manufacturers' datasheet with bespoke specifications
- Ensure system performance and durability
- Detect high-risk designs

OUR OFFER

The offer consists in:

- Support for the drafting of the specifications
- Design review
- Support and assistance during acceptance tests

The offer can be detailed as follows:

- Assistance during the drafting of the specifications
- Design review:
 - Compliance with specifications
 - Expert advice (on thermal, dielectric and mechanical performance – short-circuit resistance –)
 - Use of advanced numerical tools and calculation means for verification of the positioning of hot spots and fiber optic instrumentation, the thermal behavior in degraded mode situations, the transmission coefficient of over-voltages and the stress on the electrical installations when the transformer is energized
- For acceptance tests, support for the specification, test monitoring and review of test results for compliance with expected performance
- Assistance during on-site measurements for commissioning to verify compliance with the specifications

SECTORS OF APPLICATION

General industry, electricity producers (nuclear power plants, thermal power plants, hydraulic), tertiary ...



Plant output transformer



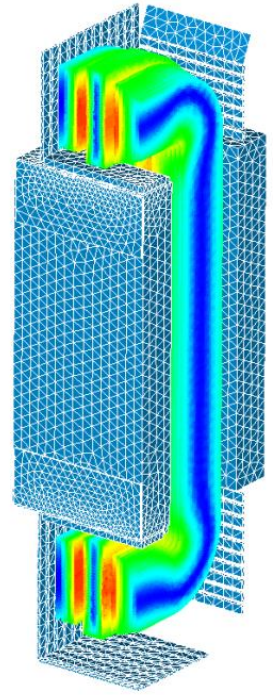
Transformer in the 63kV pumping station substation





OUR STRENGTHS

- A recognized expertise in the field of transformers, the knowledge of the industrial fabri and the mastery of the rules of the art. Technical know-how proven by industrial studie carried out on EDF's production park in the last 30 years.
- Advanced numerical simulation tools, developed in-house, in 2D and 3D, consolidated b expert industrial know-how:
 - Finite element calculation software:
 - Electromagnetism (code_Carmel)
 - Thermal (Syrthes)
 - Finite volume calculation software:
 - Thermo-hydraulics (Saturn Code)
- IT development skills allowing a total mastery of business standards.
- Support for test reviews.
- Support from EDF research engineers, experts in transformer technologies and thei applications. Assistance in defining test procedures and interpreting results.
- An R&D network with high voltage test facilities that can easily be mobilized if need be.



Modeling losses in windings

A RICH HISTORY

- Systematic assistance with type testing of transformers at manufacturers' premises for those destined for EDF production sites.
- Presentation of best practices based on the thermal characteristics of power transformers, in the introduction to session A2 (Transformer) of CIGRE 2018, by EDF R&D experts. Systematic participation in many GTs of the CIGRE A2 Technical Committee.
- Participation in IEC GTs responsible for the revision of international standards of Technical Committee 14.

SATISFIED CLIENTS

- EDF Nuclear Engineering
- EDF Hydraulics
- EDF Thermal Energies

Training
On quotation.

Studies
On quotation

Audits
On quotation.

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QUALIFYING YOUR VALVE EQUIPMENT



EDF©William Beaucardet

YOUR CHALLENGES

- To qualify valve equipment for sensitive applications
- To approve your innovative sealing solutions by having a wide range of representative conditions for water or steam tests
- To approve your modelling through specifically instrumented tests

*CYPRES-CYTHÈRE test
installations
EDF Lab Les Renardières*

SOME OF OUR EQUIPMENT

Test loops:

- > 175 b max. and 225°C max. temperature range during thermal cycling
- > 285°C max. and 160 b max. pressure differential during mechanical cycling
- > Flow rate up to 160 m³/h (demineralised and deoxygenated water)
- > Water or steam discharge up to 355°C

SECTORS OF APPLICATION

Nuclear industry
Energy
Oil and gas industry, petrochemical industry
Mechanical industries

OUR OFFER

- Thermal cycling and mechanical cycling test campaigns for manual or motorised valve equipment (valves, non-return valves, safety valves, etc.)
- Turnkey tests based on your specifications (mechanical and electrical connections, calibrated test instrumentation, expertise, etc.)
- Design and implementation of dedicated tests and instrumentation for specific needs
- Expertise





EDF©William Beaucardet

OUR STRENGTHS

- Installations that are unique in Europe: CYPRES (pressure cycling) and CYTHERE (thermal cycling) test resources
- These test installations operate throughout the year (excluding statutory scheduled shutdowns every 18 months)
- Experimental expertise backed by several decades of testing and supplemented by significant digital expertise
- Technical excellence recognised by our internal and external customers

THEY PUT THEIR TRUST IN US

EPRI (Electric Power Research Institute), USA (2017-2018): Approval of a new hard coating for valve seat sealing with the VELAN manufacturer.

DAHER-VANATOME and KSB, valve manufacturers (2012-2015): Support in the qualification of valve equipment for the Flamanville EPR.

EDF (2013-2015): Specifically instrumented thermal shock tests (for example, core thermocouples, stud strain and residual strain) to approve digital models.



EDF©William Beaucardet

TO FIND OUT MORE...

> [Assessing your equipment in two-phase flows](#)

Thermal cycling tests
On quotation

Mech. + th. cycling tests
On quotation

Mechanical cycling tests
On quotation

Specific tests and instrumentation
On quotation

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ASSESSING YOUR EQUIPMENT IN TWO-PHASE FLOWS



©DR

Two-phase test loop,
EDF Lab Chatou

YOUR CHALLENGES

- To reduce unavailability by optimising the operation and performance of your hydraulic components (exchangers, pumps, valves, non-return valves, etc.)
- To characterise and approve hydraulic components that are subjected to two-phase flows
- To develop a comprehensive research programme, by combining the experimental approach with numerical simulations

SOME OF OUR EQUIPMENT

- Single-phase or two-phase adiabatic flow
- Water/freon or water/air systems
 - Gas system ND 80
 - Water system ND 100
- Flow rates
 - Water: 100kg/s
 - Freon: 8 kg/s
 - Air: 1.5 kg/s
- Pressure 6 – 10 bars
- Temperature 20 – 40°C
- Instrumentation
 - Optical dual probe
 - Hot wire
 - Wire-mesh
 - Strain gauge
 - Rapid video

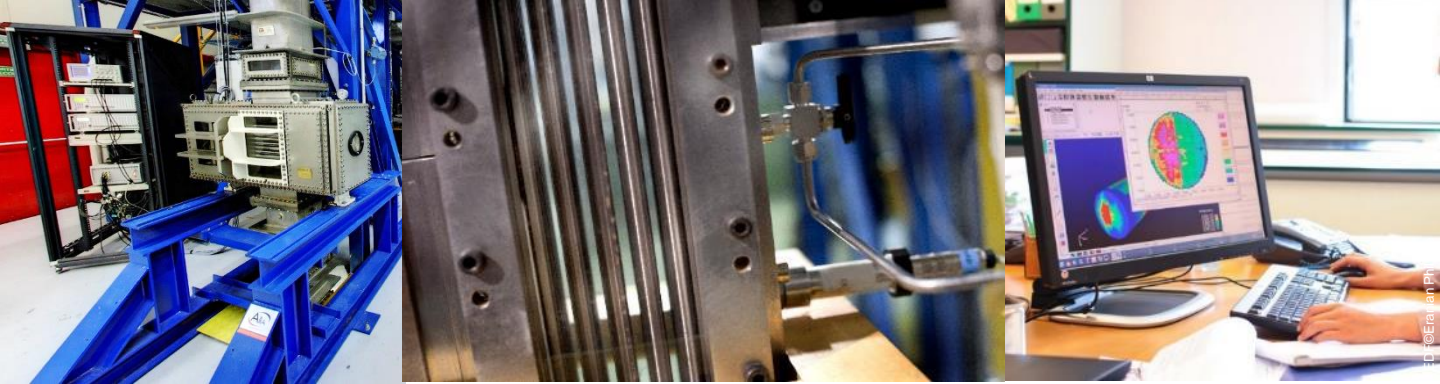
SECTORS OF APPLICATION

Energy/Oil and gas industry/Thermal industry (heat exchangers)/Nuclear industry/Research & Development

OUR OFFER

- Qualify or test all hydraulic components or systems that may be subjected to single-phase water or gas (air or freon) flows or two-phase flows.
- Optimise the characteristics or operation of your equipment, by more precisely defining two-phase flows through specific metrology.
- Provide support in the optimisation, sizing and operation of components through modelling studies.
- Consulting and expert audits.
- Develop research projects and programmes.
- Train you in our two-phase or vibratory measurement techniques and the simulation of two-phase flows.





Test resources and simulation of equipment in two-phase flows.
EDF Lab Chatou

OUR STRENGTHS

- Long-standing implementation of know-how for the French nuclear power plant pool
- Tests recognised by our partners, in France (CEA, AREVA) and abroad (the American organisation EPRI), etc.
- An experimental approach that can be supplemented by local 3D two-phase simulations
- A large-capacity test installation that is modular and flexible in its operation
- Internationally recognised scientific excellence (publications, awards, etc.)

THEY PUT THEIR TRUST IN US

AREVA: The combined approach (experimental and numerical simulation) enabled the characterisation of pressure drops in steam generator spacer plates.

EPRI (Electric Power Research Institute - USA): Design and realisation of tests used to approve steam generator thermohydraulic behaviour simulation tools.

EDF: Studies of the vibratory instability risk of nuclear power plant pool steam generator tubes.



EDF@Eranan-Philippe

Training
Audits
Studies
On quotation

Tests and measurements
By the day, on quotation

CONTACT

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DEVELOPING YOUR REPAIRS AND COATINGS

USING ADDITIVE MANUFACTURING "COLD SPRAY"



Cold Spray installation
EDF Lab Renardières site in
Moret-sur-Loing

YOUR NEEDS

- Develop methods and materials to carry out repairs and coatings by Additive Manufacturing "Cold Spray"
- To perform repairs on site controlling your costs, reliability of the process and the functionality of the repaired components
- To develop innovative materials (composition, microstructure) that conventional processes can not do
- To establish the cold spray as an additive manufacturing process for simple shapes

OUR FACILITIES

- > Cold Spray system Impact Innovation 5/11: - "Standard" and "Soft" injector>
- > 2 process gases :Nitrogen and / or Helium
- > Kuka KR-60 robot with positionner
- > 2 powder feeders
- > Spray booth compatible with ATEX environment

FIELD of APPLICATIONS

Nuclear and hydraulic production facilities / Chemical industry / Military and Aerospace industries / Electronic and Semiconductor industry / Oil and Gas sector

OUR OFFER

- R&D service: Development of research programs for innovative applications;
- Projection tests with or without characterization of the parts produced;
- Development of repair methods from the elimination of the defect, its reconstruction and the mechanical characterization of the regenerated part;
- Development of coatings for the functionalization of surfaces (corrosion resistance, wear resistance, etc.).





©DR

OUR ASSETS AND SKILLS

- A cold spray system on the cutting edge of technology;
- A large panel of sprayable powders thanks to the ATEX spray booth (aluminum, titanium...);
- A unique package combining expertise in the metallurgy and mechanic fields and in the cold spray process;
- High end characterization facilities allowing microstructural analysis from nanoscale through meso scale.

THEY TRUST IN US

CEA (2020): Tests on several nature of powders

FA3 PWR: Repair of a titanium coatings on a carbon steel

Naval Group (2020): On going discussions



Research and development work
Prices on quotation

Spraying Tests and associated characterizations
Prices are available on quotation
Considering a minimum of one day

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OPTIMIZING YOUR CHEMICAL TREATMENTS

TO CONCILIATE PERFORMANCE AND ENVIRONMENT

YOUR CHALLENGES

- Optimizing the chemical treatments (e.g. biocidal treatments) in place in order to conciliate "industrial performance", "economic viability" and "environmental and health acceptability"
- Characterize chemical releases, including unknown transformation by-products, and assess their environmental fate
- Understanding the physico-chemical and biological phenomena involved in industrial processes and in the environment
- Evaluate the environmental impact of new technologies (new chemicals or processes)
- Identify room for action and rationalize technological choices, in order to guarantee compliance with environmental regulations

SOME OF OUR EQUIPMENT

> **Sample preparation equipments:** filtration devices, automated solid phase extraction (SPE) instruments, etc.

> **High performance analytical instruments:** GC/MS and LC/MS couplings, AOX analyzers, combustion furnace/ion chromatography (CIC) coupling, UV-Vis spectrophotometers, atomic absorption spectrometers, Karl Fischer titrators, etc.

> **Field equipment & tools:** samplers, transportable mass spectrometer (MIMS), UV/Visible spectrophotometers, sensors, multi-parameter probes, etc.

> **Laboratory bioreactor and semi-industrial test facility** for industrial cooling system (sizing of chemical treatments and study of their environmental fate).

SECTORS OF APPLICATION

Industry / Facility operators in river or marine environment / Environmental agencies / Water engineering / Environmental consultants

OUR OFFER

- Experiments in laboratory, in semi-industrial testing facility and in natural field environment: process optimization (biocidal and anti-scale treatments), understanding of phenomena, evaluation of the environmental fate of chemical substances at environmentally relevant concentrations
- Development of analytical strategies and protocols, allowing to characterize chemical contaminants (including their unknown compounds) in different matrices:
 - Chemical substances: disinfection by-products (trihalomethanes, haloacetic acids, etc.), organohalogen compounds (e.g. AOX, POX, EOX, AOCl, AOBr, AOI), amines, nitrosamines, oxidants (monochloramine, chlorine, ORT), etc.
 - Matrices: natural water (fresh and saline), industrial effluents, sediments, soils, suspended solids, biota, etc.
- Consulting and expertise in analytical sciences and environmental chemistry (e.g. chlorination and monochloramination by-products)
- Writing of technical and scientific reports, based on literature review and/or experiments
- For rent : laboratories, analytical equipment (incl. training)





OUR STRENGTHS

- Complete solutions, ranging from opportunity study (technical and economical feasibility), experimentation and expertise. A gradual response, adapted to the needs and challenges.
- Skills valued by the scientific community (publications in specialized journals).
- A multidisciplinary team: coupling chemistry and ecotoxicology approaches for the identification of contaminants at risk for the ecosystems (Effect-Directed Analysis approaches, Mass Balance Analysis, etc.).

THEY PUT THEIR TRUST IN US

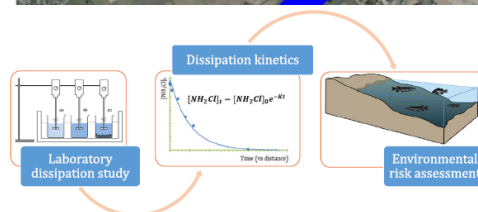
EPRI - Electric Power Research Institute (2017) : Iodine vapor infusion technology tests on cooling tower applications.

Water Technology Centre (TZW, Allemagne), Ecole Polytechnique, CNRS (2019): Partners in determination of monochloramine dissipation kinetics in various surface water qualities under relevant environmental conditions – Consequences regarding environmental risk assessment.

EDF (since 2010): Characterization of chlorination and monochloramination by-products of natural waters.

Ecole Polytechnique and CNRS (2020): Partners in tracking monochloramine decomposition in MIMS analysis.

Ecole Polytechnique and CNRS (2018): Partners in development and validation of a multiclass method for the determination of organohalogen disinfectant by-products in water samples using solid phase extraction and gas chromatography-tandem mass spectrometry.



TO FIND OUT MORE...

- [Water and infrastructure: modelling your environment](#)
- [Water and infrastructure: measuring and characterizing your environment](#)

Studies and experimental analyzes
On quotation

Training
Tailor-made training and support: on equipment, on the use of equipment (GC/MS, LC/MS, validation of methods, etc.)

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MODELLING INDUSTRIAL EMISSIONS IN THE ATMOSPHERE

YOUR CHALLENGES

- Modelling industrial emission for business as usual or accident scenarios
- Backtrack the source of the emission from environmental data
- Training in atmospheric dispersions and create R&D and innovation strategies

OUR EQUIPEMENTS

- > CFD code Code_Saturne
- > Field campaign instrumentation

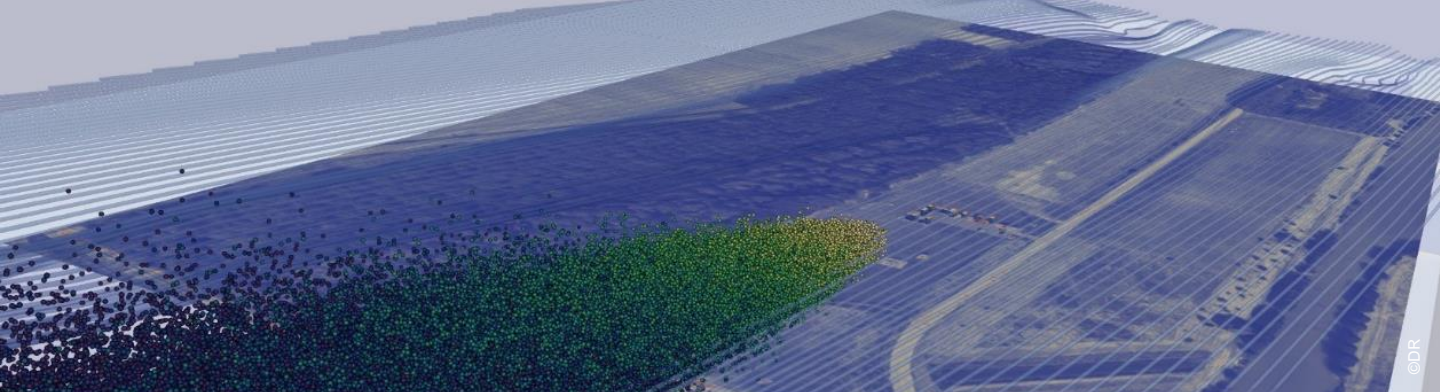
APPLICATION SECTOR

Industry, consultancy firm, Environment Authorities

OUR OFFER

- Atmospheric dispersion modelling and emission analysis for different meteorological situation. Organisation of field campaign for data collection
- Simulation of wind scenarios
- Consultancy on the crisis management plans development
- Backtrack of emission sources via inverse modelling
- Training end education on atmospheric dispersion





OUR STRENGTH

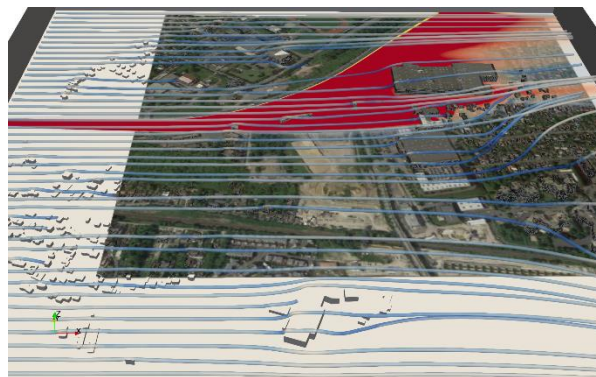
- Decades of experience with EDF industrial sites
- Links with top engineer University Ecole des Ponts ParisTech
- High level recognition in sciences and academic (publications, distinctions, university education).
- Long term training experience for an high spectrum of public from engineers to general public
- Home made development of adapted tools

THEY PUT THEIR TRUST IN US

EDF (2020): Atmospheric Dispersion modelling around EDF site

IRSN (2020): data collection and field campaign

Grand Paris (2019) : 3D visualization of air quality for a new urban area in Villiers sur Marne (Grand Paris Area) for the urban highway A4 toward the buildings



TO FIND OUT MORE

- > [Improve air quality in urban areas](#)
- > [Human factor and reliability of complex industrial system](#)

Training

On quotation. Tailor-made training possible.

Audits

On quotation.

Studies

On quotation

Tests and measurements

By the day, on quotation

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RELIABILITY, OPTIMISATION, CYBERSECURITY



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INCREASING THE RELIABILITY OF YOUR COMPLEX INDUSTRIAL SYSTEMS



YOUR CHALLENGES

- To design technical systems with guaranteed reliability and availability
- To qualitatively and quantitatively assess and prioritise risks
- To analyse and promote scenarios and to optimise them with regard to risks
- To assess the impact of a modification to a system or installation

OUR TOOLS

- > [KB3](#) software suite for discrete static and dynamic systems
- > [PyCATSHOO](#) software for discrete continuous dynamic systems

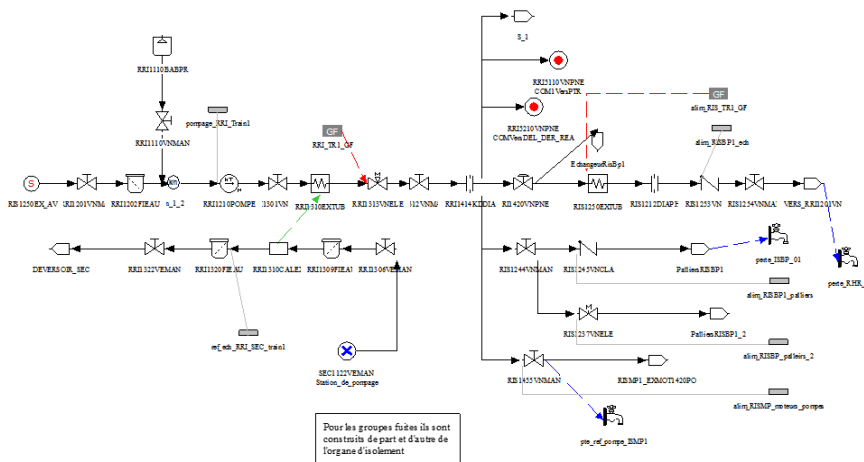
SECTORS OF APPLICATION

Nuclear industry
Oil and gas industry - Petrochemical industry
Energy, transport and other high-risk industries

OUR OFFER

- Realisation of a pilot study to assess a complex technical system
- Creation of a knowledge base specific to a business line, training and subsequent provision of the base and the tool, enabling customers to carry out several studies on their own, using a shared knowledge base
- Provision of the free version of KB3 software (limited to 80 objects) or sale of the complete version
- Provision of the free version of [PyCATSHOO](#) software (without support)
- Trainings





OUR STRENGTHS

- Tried and tested tools that go beyond those available on the market for complex systems and processes, taking into account both temporal aspects and functional interactions (equipment repairs, changes in physical parameters over time). Know-how implemented at EDF, in particular for the EDF nuclear engineering division
- Training carried out for study engineers
- Internationally recognised scientific excellence (publications, awards, higher education)
- For socio-technical systems, human and organisational aspects can also be assessed (please refer to the associated sheet)

THEY PUT THEIR TRUST IN US

EDF/Nuclear engineering division: Support in the realisation of complex system reliability studies, with the automatic generation of fault trees for systems modelled in Nuclear Safety Probabilistic Studies

EDF/Hydroelectricity engineering division: Realisation of pilot studies concerning the reliability of dams and penstock pipelines, transfer and support



TO FIND OUT MORE...

- > [Human and organisational factors in your high-risk activities](#)
- > [Optimising your maintenance investments](#)
- > [Ensuring the reliability of your industrial power networks](#)

KB3 software licence Training

- Reliability and safety of industrial systems (Ref. ARN2680)
- Use of KB3 in the context of PSA (Ref. ARN4878)

- Use of the PyCATSHOO software tool (on quotation)

Studies: on quotation

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HUMAN AND ORGANISATIONAL FACTORS IN YOUR HIGH-RISK ACTIVITIES



YOUR CHALLENGES

- You have to take on board human, collective, organisationnal and managerial dimensions to :
 - to design and to ensure the reliability and the high-risk socio-technical systems performance
 - To assess the strengths and weaknesses of your organisation in order to develop their learning ability, their resilience and to assist to their evolutions
 - to asses your crisis organisation
 - to introduce new technologies (AR/VR, AI...) in your risk systems and to lead the associate changes
 - to contributre to the demonstration of the respect of the regulatory requirements with the authorities

SOME OF OUR MODELS

- > Organisational and professional models for the management of industrial safety
- > Situation Resilience Model for the operations in accidental events and crisis management
- > Organisation performance model for the maintenance management
- > Organisation model of a learning-feedback process
- > Method for analysing major industrial accidents and leveraging lessons learnt
- > SITUATING method to transform complex and dynamic work situations into training exercises

SECTORS OF APPLICATION

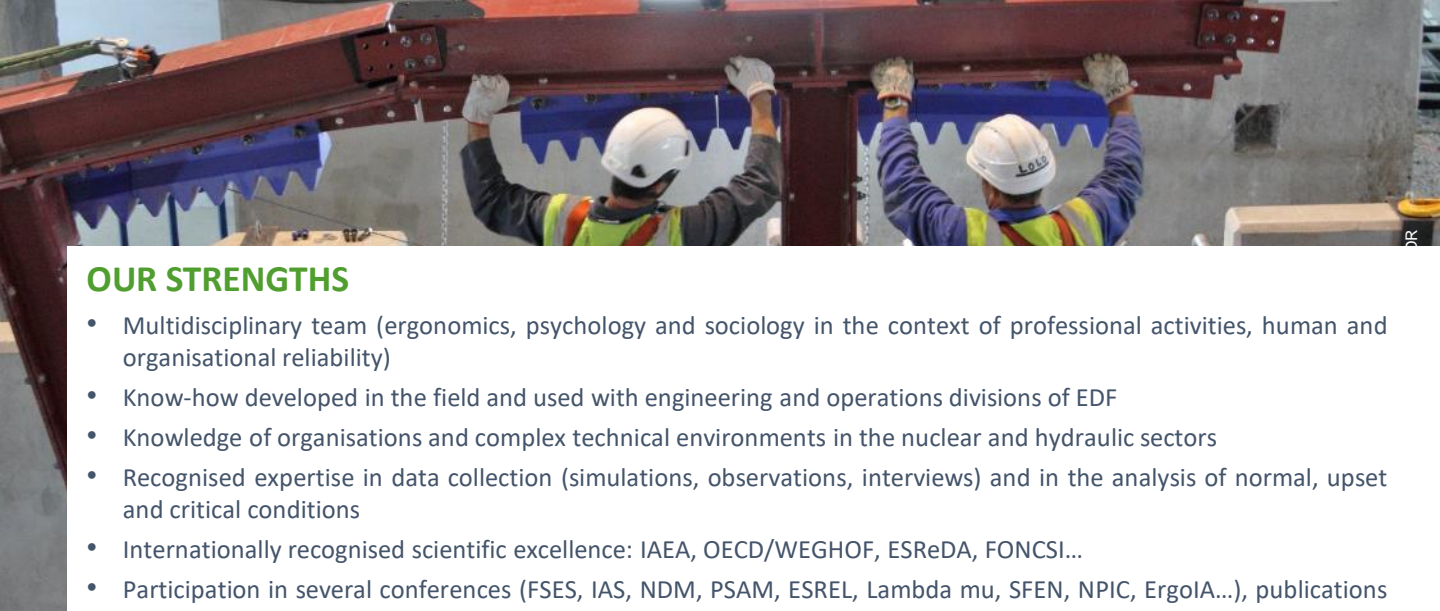
High-risk industries

Operations of complex systems (transport, chemicals, energy)

OUR OFFER

- Training sessions on the methods and models developed by EDF R&D
- Workshops on the analysis of major industrial accidents: for internal discussions and reflections on potential for improvements
- Studies on:
 - Diagnosis of organisations and follow-up recommendations
 - Integration of Human and Organisational Factors (HOF) in the design of high-risk socio-technical systems (e.g. operation centre...)
 - Management of change due to new technologies deployment (AR/VR, AI...) in high-risk activities
 - Tests of prototypes in EDF R&D ConnexLab
- R&D partnerships on HOF topics





OUR STRENGTHS

- Multidisciplinary team (ergonomics, psychology and sociology in the context of professional activities, human and organisational reliability)
- Know-how developed in the field and used with engineering and operations divisions of EDF
- Knowledge of organisations and complex technical environments in the nuclear and hydraulic sectors
- Recognised expertise in data collection (simulations, observations, interviews) and in the analysis of normal, upset and critical conditions
- Internationally recognised scientific excellence: IAEA, OECD/WEGHOF, ESReDA, FONCSI...
- Participation in several conferences (FSes, IAS, NDM, PSAM, ESREL, Lambda mu, SFEN, NPIC, ErgoIA...), publications in scientific journals
- Training courses to diverse audiences within EDF: service technicians, engineers, managers, directors...
- Training courses at Centrale Paris, UTT, CNAM, VUSQ, Nanterre, Paris 5, Paris 8, etc.
- Supervision of thesis and research activities carried out with our academic partners

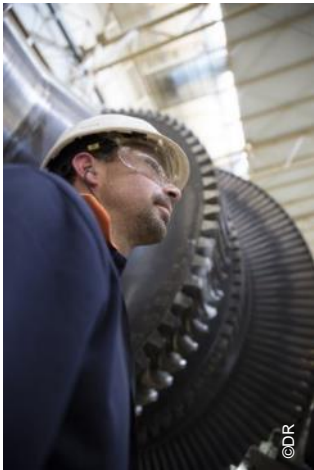
THEY PUT THEIR TRUST IN US

EDF/Nuclear engineering division: definition and implementation of engineering activities on Human and Organisational Factors, including in the design of operating control systems of nuclear new build projects (EPR, EPR2, SMR...)

EDF/Nuclear operations division: management of industrial safety, assistance in the preparation of unit outages and crisis response protocols

Industrial partners in the nuclear sector: exploration of the potential uses of new technologies (AR/VR, AI...)

EDF General Inspector for nuclear safety & radioprotection / EDF Group Risk Division: analysis and lessons learnt from major industrial accidents



TO FIND OUT MORE...

- > [Increasing the reliability of your complex industrial systems](#)

Training
Tailor-made training possible.

Studies
On quotation

CONTACT

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MANAGING THE RISKS TO YOUR ASSET PORTFOLIO

YOUR CHALLENGES

- Valuation of different types of contracts and assets on volatile commodity markets
- Quantification and management of the risks associated with commodity markets (price, volume, liquidity risk) and financial markets (interest rate risk, FX, inflation, counter-party risk)
- Evaluation of the efficiency and transaction costs of a given hedging strategy
- Selection an optimal composition of a portfolio for a given risk-return profile

SOME OF OUR TOOLS AND METHODS

- > Least Squares Monte Carlo valuation of gas storages(Risk-BU tool)
- > Efficient evaluation of different hedging strategies (based on available products, market liquidity, transaction costs, neutral zone definition ...) by dynamic delta evaluation for every price trajectory (Risk-BU tool)
- > Calibration of factorial price models of commodity prices (CARMEN tool)
- > Asset-liability simulation platform for the construction of efficient portfolios (ALM tool)

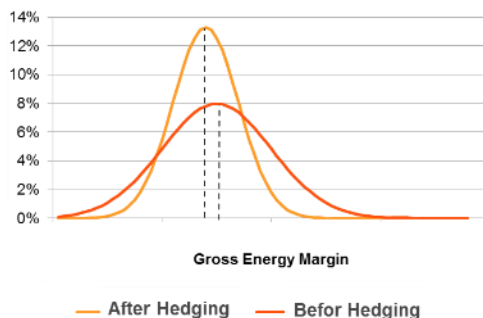
SECTORS OF APPLICATION

Commodity markets/Financial markets/Industry (with exposure to the energy and/or financial markets)

OUR OFFER

- Software applications for market risk management and valuation well adapted for commodity markets:
 - Off-the-shelf solutions
 - Custom solutions specifically designed for a client business process
- Advisory services
- Audit of quantitative models and business processes used for risk management and valuation
- Training on quantitative methods and tools for risk management and valuation





An effective hedging strategy enables risks to be reduced, by minimising transaction costs, etc.

OUR STRENGTHS

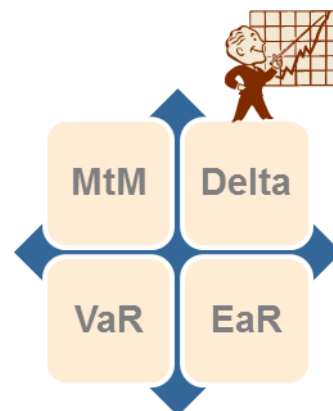
- Widely respected expertise in financial mathematics and stochastic control
- A strong track record of developing sophisticated tools for operational support different business lines of EDF Group: exposure monitoring for EDF Group and hedging strategy simulation, risk indicator calculation, mark-up calculation, asset-liability management
- Open source libraries for resolution and simulation of stochastic optimization problems found in finance and applied in energy market context (StOpt library)

THEY PUT THEIR TRUST IN US

EDF (2016): Calculation of consolidated risk indicators for the entire EDF Group, consulting on hedging strategies, valuation of exotic contracts, asset/liability management of the net financial debt portfolio (risks related to interest rates, exchange rates and liquidity).

EDF Luminus (2016): Development of a tool for Value-At-Risk calculation, enabling the operational process to be greatly simplified.

Industrial gas specialist (2016): Software solution for physical portfolio modelling and valuation in the commodity market.



TO FIND OUT MORE...

- > [Planning your operations more efficiently through innovative methods](#)
- > [Incorporating the human factor into your high-risk activities](#)

Studies & software solution
On quotation

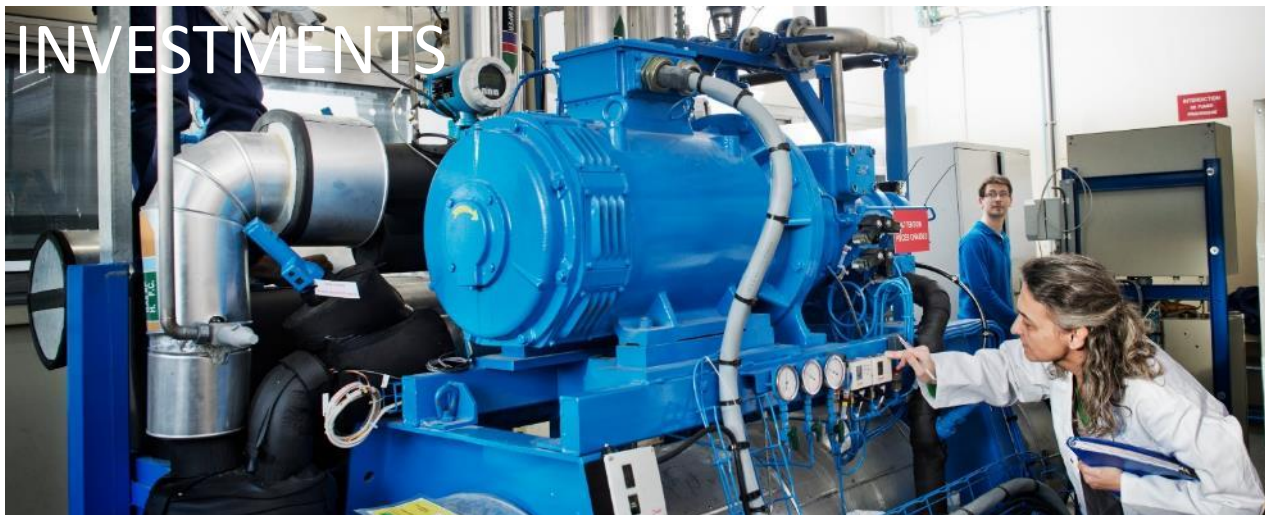
Training
On quotation

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OPTIMISING YOUR MAINTENANCE

INVESTMENTS



YOUR CHALLENGES

- To analyse your industrial asset maintenance strategies (preventive maintenance, replacement of components, increase in the stock of spare parts)
- To assess the availability or performance gains generated by expenditure related to maintenance investment
- To identify the technical and economic impact of postponing a maintenance operation or reducing the investment budget allocated and to assess the likelihood of regretting the investment
- To optimise maintenance strategy programming, in order to maximise return on investment throughout the installation's life cycle, while respecting budgetary constraints

SOME OF OUR SOFTWARE TOOLS

Our software use Markov processes, genetic algorithms and Monte-Carlo simulations.

> VME software (Exceptional Maintenance Valuation)

> IPOP software (Industrial Portfolio Optimal Planning)

SECTORS OF APPLICATION

All capital-intensive industrial installations (Energy, Networks, Transport, Oil & Gas, etc.)

OUR OFFER

- Performance of a business line issue analysis
- Construction of the case study with you: modelling of the technical-economic system, characterisation of input data and associated uncertainties (for example, component reliability, storage cost, etc.)
- Realisation of a pilot study together with associated sensitivity studies
- Strategy optimisation to maximise return on investment while respecting budgetary, industrial, logistical, human and regulatory constraints
- "Tailor-made" training courses





OUR STRENGTHS

- Know-how implemented across the EDF Group's production plant pool (Nuclear, Hydroelectricity, Thermal, Renewable energies, Distribution network)
- More than 50 studies carried out within EDF
- Targeted training: project leaders, study engineers, managers, financial engineers, maintenance managers
- Internationally recognised scientific excellence (publications, awards, higher education)

THEY PUT THEIR TRUST IN US

EDF (2016): Nuclear - Analysis of investment files in the context of the "Major overhaul of the French plant pool" programme

EDF (2016): Hydroelectricity - Assessment of the benefit of carrying out equipment renovation in a production plant

EDF EN (2016): Assessment of various offshore wind farm maintenance scenarios, taking into account offshore accessibility

IREQ-HYDROQUEBEC (Canada) (2015-2016): Realisation of an assessment of the technical-economic benefit of purchasing an additional spare part

EPRI (United States) (2015-2016): Evaluation of the economic impact of a modification to a safety component (in the USA context)



TO FIND OUT MORE...

- > [Increasing the reliability of your complex industrial systems](#)

Training
On quotation

Studies
On quotation



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PLANNING YOUR OPERATIONS MORE EFFICIENTLY THROUGH INNOVATIVE METHODS

YOUR CHALLENGES

- To reduce the costs associated with the overproduction of goods, their storage or congestion of production facilities
- To better understand and anticipate the behaviour of your customers and consumers in order to increase their satisfaction
- To use the data you have available and to automate your processing, in order to initiate a predictive and prescriptive approach

SOME OF OUR TOOLS AND METHODS

- > Methods used to calculate aggregate power consumption forecasts
- > Adaptive forecast models that can be deployed on large volumes of data, in order to forecast electrical and gas data, consumption or production. Probabilistic forecasting tools: application for risk vision (GAM tool suite)
- > Library of predictor aggregation through the combination of assessments, for consumption, production and price forecasting: (Opera tools and calculation libraries)
- > Online forecasting platform for the use and deployment of permutation algorithms (Havana tool)

SECTORS OF APPLICATION

Energy/Transport/Distribution/Environment/Marketing

OUR OFFER

- Analysis of needs and formalisation of forecasting problems, development of models and prototypes, from raw data to the final forecast
- Development of complete software solutions and decision-making support tools adapted to your needs
- Support in the selection of off-the-shelf forecasting solutions
- Audit of existing forecasting models
- Development of a tailor-made training programme focusing on the state of the art in the field or directly focused on your practical applications





OUR STRENGTHS

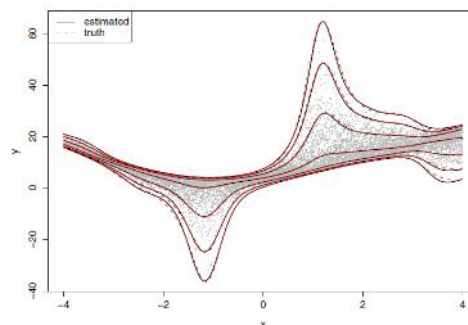
- Skills and know-how recognised within the EDF Group's various business lines: forecasts of national portfolio and customer cluster electricity consumption, forecasts for "smart grids", gas consumption forecasts, market price forecasts, wind production forecasts.
- Know-how in the development of high-performance industrial codes and in the development of rapid prototypes.
- Internationally recognised scientific excellence (publications, awards, education).

THEY PUT THEIR TRUST IN US

EDF SA (2015): 2015 innovation award for the resolution of a peak forecasting problem in the group's call centres, in order to optimise and develop schedules.

EDF SA (2016): Short-term, medium-term and long-term operational forecasting of the consumption of EDF's customer portfolios to manage the supply-demand balance.

Enedis (2016): Modelling and development of forecasting models for smart grids: provision of thousands of forecasting models, for forecasts ranging from the intraday level to several years, to operate and schedule tomorrow's networks.



TO FIND OUT MORE...

- > [Managing the risks to your asset portfolio](#)
- > [Optimising your maintenance investments](#)
- > [Improving your heat demand forecasts](#)

Studies
On quotation

Training
On quotation

Software production
On quotation



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CHOOSING THE RIGHT ALGORITHM FOR YOUR OPERATIONAL DECISIONS

YOUR CHALLENGES

- To make strategic decisions: investment choices, sizing of installation assets or a fleet
- To optimise and accelerate the operation of your daily decision-making processes by incorporating a large amount of information and the constraints that must be respected
- To train your teams in the theory and implementation of optimisation techniques

SOME OF OUR TOOLS AND METHODS

- > Calculation of daily schedules for power plants in France using a Lagrangian relaxation algorithm (APOGENE tool)
- > Management of hydraulic reservoirs through stochastic dynamic programming (MORGANE tool)
- > Optimisation of a gas portfolio through integer linear programming (GOEMON tool)
- > Scheduling of nuclear power plant outage in France using a local search method (ARTEMIS tool)

SECTORS OF APPLICATION

Energy/Logistics/Resource management (human and material)

OUR OFFER

- Analysis of needs and formalisation of decision-making problems, development of models and prototypes
- Development of complete software solutions and decision-making support tools adapted to your needs
- Support in the selection of off-the-shelf optimisation solutions
- Audit of existing optimisation models
- Development of a tailor-made training programme focusing on the state of the art in the field or directly focused on your practical applications





OUR STRENGTHS

- Skills and know-how that are recognised within EDF Group's various business lines: management of the EDF portfolio (production assets, customer contracts and financial contracts), optimisation of vehicle routing, human resource management for customer relations activities
- Know-how in the development of high-performance industrial optimisation codes
- Internationally recognised scientific excellence (publications, awards, education)

THEY PUT THEIR TRUST IN US

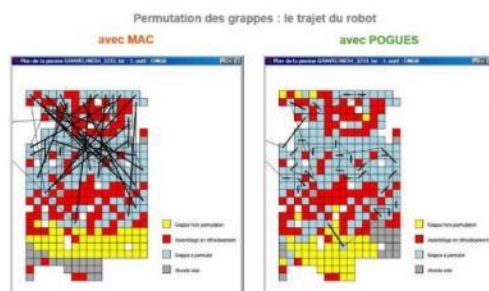
EDF SA (2016): 2016 "engineering" innovation award in the Operational Plant Pool Challenge for the development of code to optimise the management of material resources during refuelling operations.

Dunkirk LNG (2016): Optimisation of LNG tanker arrival schedules at the Dunkirk terminal to manage scheduling conflicts.

Agri-food industry (2016): Methodological support in the consideration of uncertainties (demand and production) in the energy management process for a manufacturer.

Enedis (2016): Modelling and supply of decision-making support tools for the optimisation of technician intervention routes: from strategic planning (opening/closing of centres in the next 15 years) to operational planning (officer rounds).

EDF SA (2016): Modelling and supply of decision-making support tools for the management of the EDF production plant pool (investment choices, maintenance schedules and development of the production programme).



TO FIND OUT MORE...

- > [Managing the risks to your asset portfolio](#)
- > [Planning your operations more efficiently through innovative methods](#)
- > [Optimising your maintenance investments](#)

Studies, audits
On quotation

Training
On quotation

Software development
On quotation

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MANAGING THE RISK OF YOUR INDUSTRIAL INFRASTRUCTURES WITH CYPH-R

EDF©Warc Caraveo

YOUR CHALLENGES

- To identify the safety needs and the vulnerabilities of your information systems
- To perform risk assessment studies in compliance with ANSSI methods & standards
- To identify the most appropriate safety measures for your infrastructures

SOME OF OUR PRODUCTS

- > Knowledge of the EBIOS methodology (developed by French cybersecurity agency ANSSI) and participation to the EBIOS club
- > Significant experience in risk assessments
- > Strong knowledge of EDF Group business lines and activities (nuclear, distribution...)
- > Knowledge of the different standards related to safety and risk management (ISO 27001, ISO/IEC 27005) and of regulatory requirements (GDPR, UE regulation, French regulation)

SECTORS OF APPLICATION

Operator of critical infrastructure (energy, utility, transport, etc.) / manufacturer of equipment who wants to secure its critical information systems (production, industrial process control, management of confidential information, etc.)

OUR OFFER

- Assistance and consulting on risk management, identification of safety measures and implementation of safety management systems
- Risk analysis based on EBIOS methodology, using dedicated tool "CYPH-R"
- Licence of CYPH-R tool
- Support or training on the use of CYPH-R tool





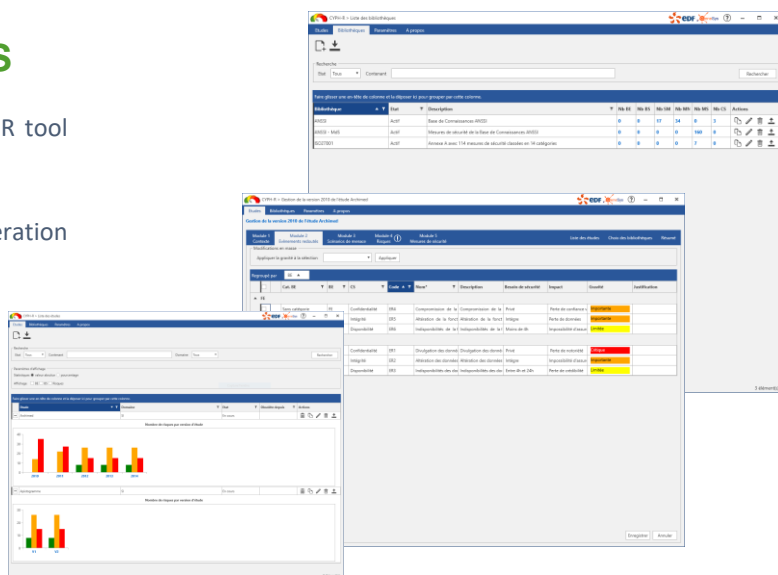
OUR STRENGTHS

- Significant experience in risk analysis using EBIOS method with EDF Business Units (ENEDIS, EDF Renewables, etc.) and more generally extensive knowledge of regulations and standards
- 15 years of experience in cybersecurity and on major vulnerabilities of industrial systems (SCADA, PLC, Modbus protocols, OPC-UA, S7, etc.)
- A close relationship with our clients which enables us to provide customized solutions with a high added value

THEY PUT THEIR TRUST IN US

EDVANCE (2018): EBIOS risk analysis with CYPH-R tool for EPR2 type nuclear plant

EDF Renewables (2017): Risk analysis on generation plants, including an onshore wind farm



Studies
On quotation

Training
On quotation

Equipment tests
On quotation

CONTACT

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POWER GENERATION



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PROMOTING THE TERRITORIAL ROOTING OF YOUR INDUSTRIAL PROJECT AND THE STAKEHOLDER DIALOGUE



YOUR CHALLENGES

- To anticipate and assist you in the construction of relationship with local stakeholder within the territory
- To organise stakeholder dialogue by accompanying you through public consultation
- To understand changes in public opinion related to your projects
- To clarify your questions of acceptability and land use conflicts

SOME OF OUR TOOLS AND METHODS

- > Literature survey in participatory consultation methods
- > Cartography of stakeholders
- > Specialised in sustainable development issues since 1992
- > Qualitative surveys (focus groups, individual interviews) and quantitative surveys (polls)
- > Text mining (Alceste and Tropes software)
- > Geographical Information Systems
- > Controversy analysis
- > Semiotic analysis
- > Investigations and opinion polls
- > Ethnography

YOUR SECTOR

Public consultation of industrial, development or territorial projects

OUR OFFER

- Guidance in your industrial project's public consultation and assistance in project management:
 - Evaluation of existing or projected systems, feedback loops construction, advice on methodology
 - Training of your project managers to the used methods and tools
 - Production of a summary of the state of opinion
 - Analysis of the understanding of technical or technological uses, including those that are currently emerging (appropriation, controversies)
- Design of ad-hoc conferences and seminars





The six key stages of a consultation process involving elected representatives.

Source: Elected representatives and consultation - a guide to stakeholder engagement

OUR STRENGTHS

- Experience in opinion analysis since 1992 for various EDF Group business lines: hydraulics, electricity transmission and distribution systems, nuclear power stations, fossil fuel power plants
- A methodological innovation practice on opinion analysis tools, in line with the progress of artificial intelligence
- Experience in the transfer of learnt-experiences to an audience of operational staff and managers
- A network of partners: academics, associations, foundations, consultants, etc.
- Recognised scientific excellence in the sociology of public opinion, environmental controversies and innovation

THEY HAVE CHOSEN US

EDF – ADEME, VENTEEA project (2015) – societal and territorial review of a wind turbine demonstrator in the Aube department

EDF (2016) – Sustainable Development Division: Elected representatives and consultation - a guide to stakeholder engagement

Social and Environmental Economic Council (2014): Expertise for the "Dialogue between stakeholders and economic development" guideline

EDF - R&D (since 2013): Participation in the steering committee and involvement in the [NanoResp](#) Forum; feedback on "Three years of dialogue with stakeholders on nanotechnologies"



TO FIND OUT MORE...

- > [Anticipating societal changes and their impact on your activities](#)
- > [Creating new digital interaction channels with your customers](#)

Studies & Consulting
On quotation

Training
On quotation

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WATER & INFRASTRUCTURES: CONTROLLING YOUR IMPACT



EDF/Aldo Spetber

YOUR CHALLENGES

- To understand the operation of an ecosystem at coastal or watershed level, and interactions with urban and industrial installations
- To assess the natural risks
- To assess the ecological status and impact of an industrial installation or development
- To think up innovative solutions to mitigate anthropogenic effects: fish-ways, renaturation of waterways, etc.
- To predict the effects of global warming
- To manage the multiple uses of water with respect to your needs
- To size your river and coastal infrastructures

*Hydraulic tests on a small-scale dam.
EDF Lab Chatou*

SOME OF OUR EQUIPMENT

- A 10,000 m² hydraulic model test facility with swell current canals and ponds
- A 60 x 20 m tank equipped with a multi-directional wave-making machine
- A natural environment measurement team
- An environmental hydraulics modelling code developed internally ([TELEMAC-MASCARET](#))

SECTORS OF APPLICATION

Urban planning / River and maritime port infrastructures / Offshore industry

OUR OFFER

We propose a cross-cutting offer in hydraulic and environmental sciences, in order to have a comprehensive understanding of the issues:

- Digital and experimental modelling of river and sea flows, morphological changes, swell and ecology
- Assess the force exerted on structures by currents and wave loads, with a view to their sizing
- Assess natural risks: floods, low flows, clogging of industrial installations (sediments, fish, plants and algae)
- Simulate the behaviour of chemical substances in surface waters, agricultural soils, the atmosphere, aquatic organisms, plants, mammals and the human organism





OUR STRENGTHS

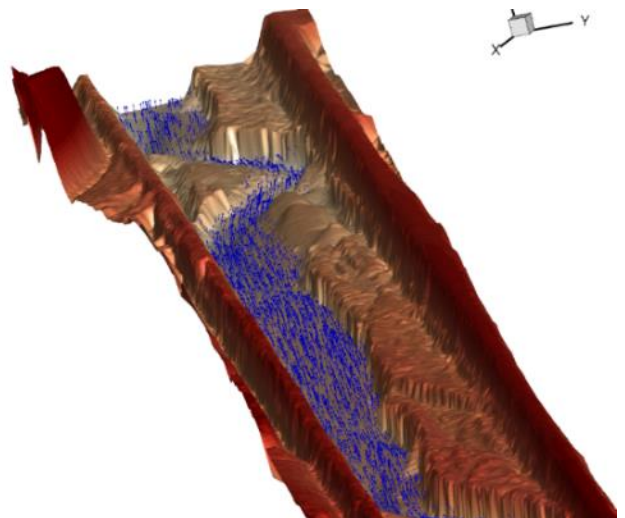
- Assessment resources used in support of EDF's hydraulic safety and environmental issues since 1946
- Transparency in the implementation of assessments
- A broad, comprehensive offer that enables each problem to be accurately dealt with
- Mastery of calculation tools through involvement in their very development

THEY PUT THEIR TRUST IN US

Artelia, CEREMA, HR Wallingford: Since 2011, EDF tools have been co-distributed under Open Source licence through the [TELEMAC-MASCARET](http://www.opentelemac.org) consortium (www.opentelemac.org), within which these major public and private design offices are involved. These tools are used by the French flood forecasting department (SCHAPI, SPC).

ONEMA: A partner since the 1980s, this organisation relies on the EDF R&D division to reinforce its expertise in fish migration and fish-way sizing.

EDF Énergies Nouvelles: Several studies have been carried out for our subsidiary, including the sizing of offshore wind turbine foundations (2014), the modelling of floating wind turbines (2012-2016), the modelling of wave turbine productivity, ocean metrology assessments (long-term monitoring of wind, wave and current measurements on a maritime site, in order to extract natural condition statistics), etc.



Sedimentary evolution of a river: digital modelling (TELEMAC) and physical model tests at EDF lab Chatou

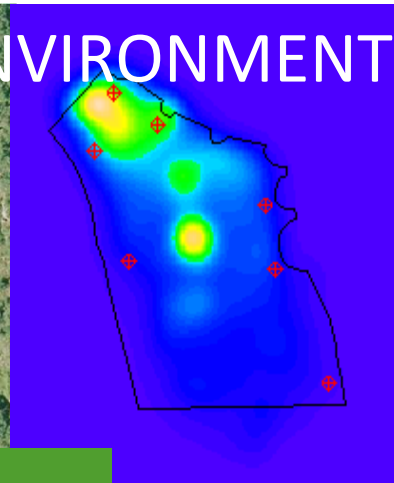
Training:
Sedimentology in rivers and reservoirs
(Ref. ARN4860)

Tailor-made training courses / Audits / Studies / Tests and measurements
On quotation

CONTACT

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WATER & INFRASTRUCTURES : MEASURING AND CHARACTERIZING YOUR ENVIRONMENT



YOUR CHALLENGES

- To measure physico-chemical parameters in water (ex. environmental monitoring)
- To characterize flow patterns in water bodies, and sediment dynamics
- To develop and calibrate hydraulics numerical models
- To study the behavior of aquatic organisms near an infrastructure (ex. to evaluate the efficiency of a fish pass; to prevent clogging)

Hydrophones (Lotek) installation campaign, to evaluate the efficiency of Poutès dam fish pass (France)

SOME OF OUR EQUIPMENT

> **Navigation** : rigid and inflatable boats (Zodiac), aquatic drones (Riverdrone, ROV Guardian Subseatech)

> **Measurement device** : electromagnetic flowmeter (OTT), aDcp (acoustic Doppler current profiler) (Teledyne, Sontek), LSPIV (Large Scale Particle Image Velocimetry), mono- and multi- parameter probes (NKE, YSI), radio-tracking (ATS), sedimentometer (Altus NKE), laser granulometer, depth sensor...

> **Positioning tools and mapping** : differential GPS (RTK – LEICA)

> **Inspection tools** : acoustic camera ARIS, DTX (Biosonics), Blueview (Teledyne)

> **Testing lab** : to evaluate and develop equipment

> **Sediment laboratory**

> **Numerical modelling software**, home-developed (ex. TELEMAT-MASCARET, Code_Saturne...)

SECTORS OF APPLICATION

Industry / River, marine, coastal, port infrastructures / Environmental agencies

OUR OFFER

- Definition et choice of measurement and sampling strategies (one-time or repeated/periodic/seasonal), complying with standard regulations, and the local context
- Organization et realization of field campaign (ex. in-situ sampling, measurement, observation, counting, inventory, survey...)
- Advanced treatment of data, signal, images... relying on our multi-expertise R&D team
- Analysis and interpretation of acquired data, reporting, expertise, diagnosis...





Flow characterization campaign (aDcp et in-air LSPiV) on the Rhine river, during a flood event – Rhinau dam

OUR STRENGTHS

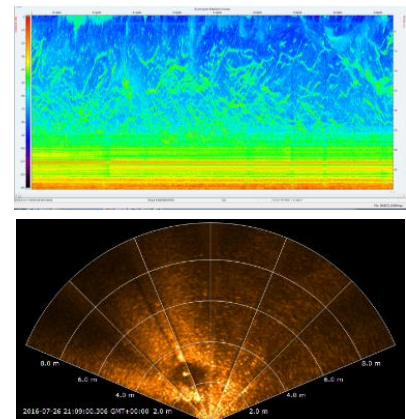
- 50+ years of experience at LNHE (National Laboratory for Hydraulics and the Environment) in aquatic environment metrology, with excellent knowledge of field conditions, and industrial context
- A broad spectrum of skills (hydrobiology, ecotoxicology, chemistry, sedimentology, currentology...), allowing us to offer a comprehensive solution
- A large stock of equipment, and specific laboratories, regularly updated with the newest technologies

THEY PUT THEIR TRUST IN US

Rhinau EDF dam (2017) : flow data acquisition, during a flood event, and 3D hydro-sediment modelling.

Poutès EDF dam, with the support of Amber European project (2014-2018) : evaluation of the salmon fish pass, during migration season (currentology, 3D telemetry, development of a 3D model); improvement suggestions for the fish pass and for the dam operation.

EDF nuclear power plant, coastal site (2014-2020) : Detection, monitoring and analysis of the juvenile fish population, near the water intake, to prevent filter clogging. Development of a real-time warning device, in close partnership with probe manufacturers.



Juvenile fish population monitoring, with DTX sonar and acoustic camera Blueview M900, near the water intake of a coastal nuclear power plant

TO FIND OUT MORE...

- > [Water and infrastructures : modelling your environment](#)
- > [Optimizing your chemical treatments, to conciliate performance and environment](#)

Studies and field campaign :
On quotation

Training with EDF ITECH :
Software : TELEMAR, code_saturne, etc.
Sedimentology in river environment and dams

Tailor-made training : on quotation

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WATER & INFRASTRUCTURES: MODELLING YOUR ENVIRONMENT



EDF/Aldo Sperber

YOUR CHALLENGES

- To study the interactions between the environment and industrial, marine or river infrastructures
- To assess natural risks, to guarantee security versus flood, storm, surge, draught, heat wave, or clogging of water intakes (by sediments, fish, jellyfish, plants and algae, etc.)
- To characterize extreme events, or global warming effects, and to design adjustments
- To dimension your coastal or river infrastructures, complying with environmental regulation and local constraints
- To create innovative solutions, which combine performance with environmental and sanitary acceptance (ex. fish pass, river continuity, restoration/renaturation of water bodies, etc.)
- To manage the multiple uses of water with respect to your needs

Hydraulic experiments
on a reduced-scale
dam model.
EDF Lab Chatou

SOME OF OUR EQUIPMENT

- A 10,000 m² hydraulic physical modelling hall, equipped with basins and flumes, to simulate wave and current
- A 50 x 30 m tank equipped with a multi-directional wavemaker
- Advanced technology : CAD design, 3D printer, laser velocity measurement, scanner, etc.
- Our home developed and Open-Sourced environmental hydraulics modelling software system ([TELEMAC-MASCARET](#))
- A team dedicated to on-site field measurements and catchments
- Laboratories in chemistry, microbiology, ecotoxicology...

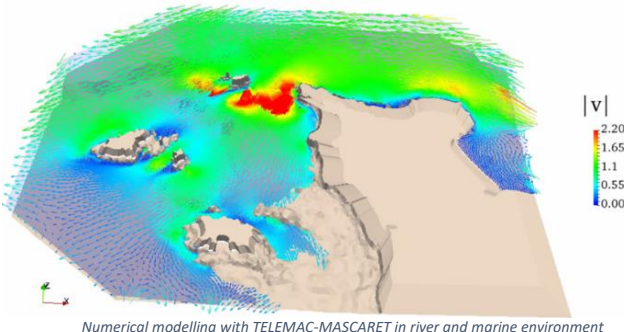
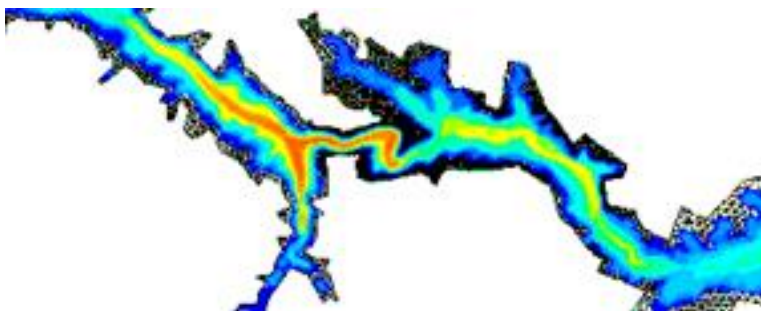
SECTORS OF APPLICATION

Public authorities / Urban planning / Industry / River, marine, coastal, port infrastructures / Offshore industry

OUR OFFER

- Numerical and experimental modelling of river and ocean/sea phenomena : flow, current, wave, swell, tide, sediment transport and morphological evolution
- Simulation/modelling of water quality
- Exposure assessment for human populations and environmental compartments (including modelling of chemical behaviour in water bodies, ground, atmosphere, biological and human organisms, by pharmaco-kinetics)
- Expertise, Audit, Owner assistance in : design, specification, construction, operation, counter-expertise of physical and numerical models
- Facilities for rent : basins and flumes
- Equipment for rent : measuring device, scale models, etc.
- Measurement, catchment, monitoring : field/on-site, or on a scale model





OUR STRENGTHS

- Our historical expertise since 1946 (LNHE – National Laboratory for Hydraulics and the Environment)
- Our broad, comprehensive offer, that enables us to solve each problem accurately
- We master calculation software, by involving in their development
- Our ability to deal with complex cases (ex. turbulence, vibration, data treatment, etc.), through our R&D network
- Our applied-research background, tightly interacting with EDF's engineering and operation units

THEY PUT THEIR TRUST IN US

Artelia, CEREMA, HR Wallingford, BAW, Cerfacs, Daresbury Laboratory (since 2011) : consortium for Open Source distribution of [TELEMAC-MASCARET](http://opentelemac.org) (opentelemac.org) integrated suite of solvers (used by the French flood forecasting department SCHAPI, SPC).

Yuansuan, China SaaS Cloud project (2020) : expertise and training on [TELEMAC-MASCARET](#) solvers, assistance with technical project realization.

EPRI (2012): shared experience in power plant cooling water filtration.

EDF Renewables (since 2012) : hydrodynamic studies for offshore wind and floating wind turbines dimension. Expertise on : ocean weather data, marine current turbines, swell energy, etc.

French Biodiversity Agency (AFB) (since 1982) : expertise partner on fish migration and fish-pass design.

ENPC, CEREMA (since 2008) : «Saint Venant» common hydraulics laboratory

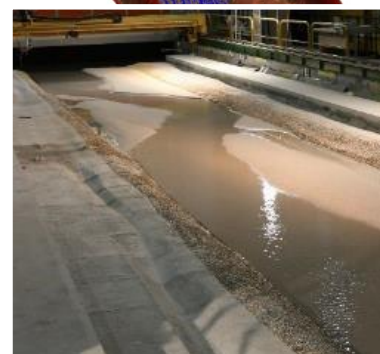
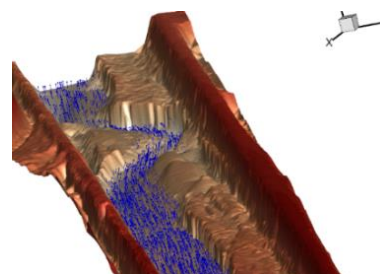
INRAE ex-IRSTEA (since 2009) : «Hynes» common research team on hydroecology
CNRS (since 2018) : «Melusine» common research team on effluent treatment processes + Partner in chemistry, microbiology, radioecology

IRSN, CEA : radioecology partner

INERIS : ecotoxicology partner

IFREMER, MNHN : biodiversity partner

Deltares : water quality partner



River sediment transport and erosion : numerical (TELEMAC) and physical modelling at EDF Lab Chatou

TO FIND OUT MORE...

- > [Water and infrastructures : measuring and characterizing your environment](#)
- > [Optimizing your chemical treatments, to conciliate performance and environment](#)

Studies and experiments :
On quotation

Training with EDF ITECH :

TELEMAC solvers : SALOME, SALOME-HYDRO,
TELEMAC-2D, TELEMAC-3D

Sedimentology in rivers and reservoirs

Tailor-made training courses

CONTACT

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EVALUATING THE SEISMIC RISK AND FACILITY RESISTANCE



YOUR CHALLENGES

- Assess the risk of seismic induced faults in equipment
- Validate the performance of structures and equipment under seismic loading

OUR OFFER

SOME OF OUR EQUIPMENT

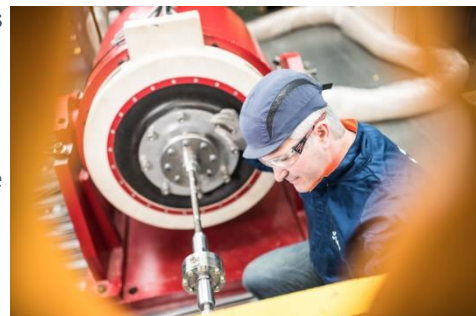
- > EVADYN test bench:
 - 42t massive
 - 4mx4m isolated from civil engineering
 - Vibration pots from 10N to 27kN
 - Fully equipped with modern instrumentation

Assessment of the seismic risk of a facility and its equipment:

- Seismic hazard through seismology
- Site effects (soil knowledge)
- The interaction between soil and structure
- The behavior and strength of the structure (concrete, backfill...)
- The foundation - equipment interaction
- Behavior and resilience of the equipment

This offer is intended for:

- Seismic risk assessment by integrating the entire analytical chain from the fault to structures and equipment
- Performance validation of structures and equipment under seismic loading
- **We offer you:**
- Methodological advice and expert opinion on the entire seismic risk chain
- Advanced studies on the basis of numerical simulation
- Validation of models by means of laboratory or on-site tests



Vibration pot simulating seismic loading

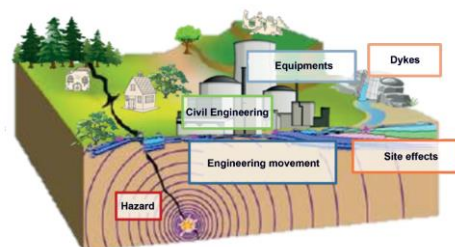


Diagram of the seismic hazard principle

SECTORS OF APPLICATION

Energy, high-risk industries (petro-chemistry), cement plants, insurance companies

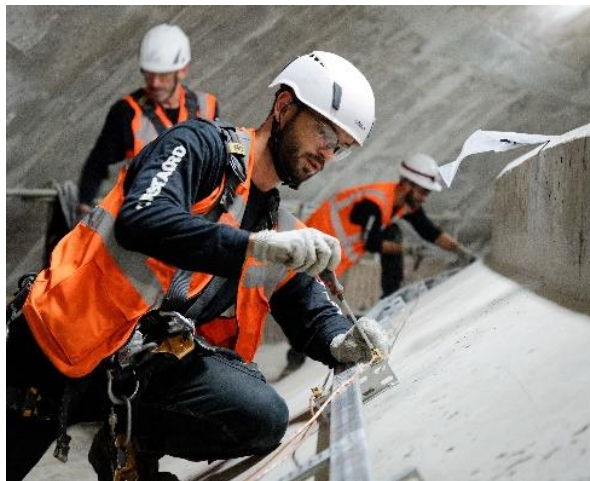


OUR STRENGTHS

- Expertise in seismology, geotechnics, civil engineering and structural dynamics.
- Numerical simulation tools for site effects, soil-structure interaction and structural behavior, based on code_aster (open source thermomechanical solver) hosted in Salome_Meca.
- Testing facilities to test the equipment's performance in the event of an earthquake.

A RICH HISTORY

- EDF has strong partnerships, notably with, the SEISM institute (BRGM, CEA, CentraleSupélec, CNRS, EDF, ENS Paris-Saclay) and the Association Française du Génie ParaSismique (AFPS).
- EDF is working jointly with the CEA and the IAEA on methods and tools to qualify and evaluate the results of probabilistic seismic hazard models
- EDF participates in the update of the RCC-M codification (design and construction rule for nuclear equipment)
- EDF works with design offices in connection with the management of earthquake structures (e. g. ARTELIA, EGIS, Geodynamics & Structures, INGEROP, SIXENSE Necs and TRACTEBEL).



Instrumentation du système de détection de séisme dans l'espace entre enceinte du bâtiment

SATISFIED CLIENTS

- EDF Nuclear, thermal and hydraulic generation plants
- CEA
- AIEA

Audits
On quotation.

Tests and measurements
By the day, on quotation

Studies
On quotation

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TESTING THE PERFORMANCE OF YOUR PHOTOVOLTAIC SYSTEMS

YOUR CHALLENGES

- To characterise and approve a product or integrated solution for the production of photovoltaic electricity
- To assess the initial and long-term behaviour of modules and their systems (inverters, etc.)
- To develop sizing tools for photovoltaic projects in various sectors (tertiary, industrial, residential, centralised)
- To define a research programme and/or develop test resources associated with photovoltaic production

*UV pre-treatment facility
in the PV LAB on the EDF Lab
Les Renardières site in Moret-
sur-Loing*

SOME OF OUR EQUIPMENT

- > Solar impulse simulator (AAA category)
- > 2 accelerated ageing chambers
- > 1 UV-Visible chamber
- > 1 high-resolution electroluminescence chamber
- > Pre-treatment facility
- > Modular external platform connected to the "Concept Grid" local experimental network

SECTORS OF APPLICATION

Photovoltaic installer sector / Centralised production / Solution integrator for

OUR OFFER

- Trial and test campaigns of all technologies.
- Modelling studies of photovoltaic installations and optimisation of their sizing and management.
- Set-up of research projects and programmes on centralised and decentralised photovoltaic systems.





Climatic chamber in
EDF Lab Les
Renardières,
Moret-sur-Loing

©William Beaucardet

OUR STRENGTHS

- Know-how implemented in support of EDF Energies Nouvelles (EN) and its subsidiaries (EDF Group).
- Multi-physical modelling tools, enabling work to be carried out from the module level to the PV equipment level.
- Training provided for a wide range of audiences (researchers, study engineers, etc.).
- Internationally recognised scientific excellence (publications, awards, higher education).

THEY PUT THEIR TRUST IN US

Off Grid Electric (2016): Assessment of equipment characteristics. In particular, we carried out a characterisation campaign of the modules used in their offers.

EDF Energies Nouvelles (since 2010): Study of module qualification and ageing. Assessment of specific deterioration. Realisation of innovative production systems.

EDF Energies Nouvelles (2016): Development of a self-consumption manager used to control the production of domestic hot water and electrochemical storage depending on photovoltaic production.



Solar impulse
simulator

©William Beaucardet

TO FIND OUT MORE...

- > [Testing and developing your batteries](#)
- > [Validating your equipment in an experimental smart grid](#)
- > [Solar energy at EDF EN](#)

Studies

On quotation

Tests and measurements

By the day, on quotation

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IMPROVING THE RELIABILITY OF THE ROTORS OF YOUR GENERATORS



YOUR CHALLENGES

- To improve the availability of your generators: to avoid unplanned shutdowns that immobilise the entire production facility
- To improve performance: to prepare maintenance/repair operations without having to stop the process
- To anticipate unexpected incidents: to prevent serious damage to a turbine generator

OUR EQUIPMENT

The NYMFEA generator diagnostic solution was developed by EDF R&D (*patented solution*)

> Simple: 4 indicator lights on a box visually indicate a fault

> Output (4-20mA) that can be linked to a monitoring system

> Acquisition on a single SD card for subsequent data processing

> Developed for 2-pole and 4-pole generators fitted with magnetic air gap sensors (flow sensor)

SECTORS OF APPLICATION

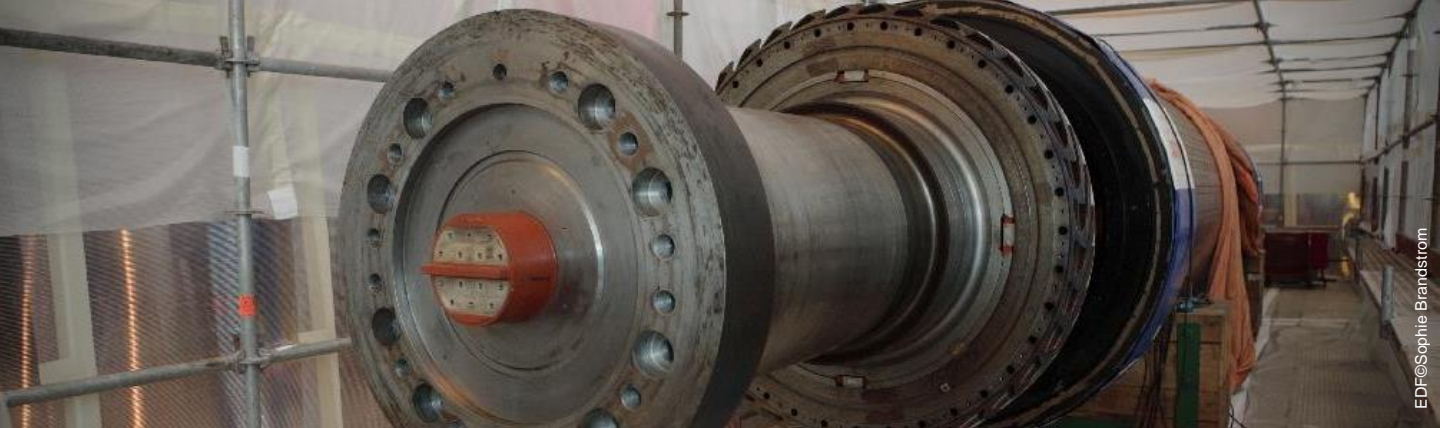
Electricity production/Turbine generators/Research & development

OUR OFFER

Based on our high-performance, easy-to-use (patented) NYMFEA diagnostic solution, we offer:

- Either the sale and installation of the NYMFEA solution and training in its use
- Or a diagnostic service for your generators





OUR STRENGTHS

- Highly efficient (patented) unique diagnostic solution: on-line detection of major rotor defects (short-circuit between turns and eccentricity faults). Ability to determine the nature of the fault and its radial location
- Years of modelling, know-how and expertise in the field of EDF plant pool generators are incorporated into the software
- "Plug and play" solution based on a flow sensor installed in the generator, energy self-sufficient and extremely simple to use
- Highly economical solution for turbine generator rotors

THEY PUT THEIR TRUST IN US

EDF nuclear and thermal power plants: Currently being deployed in EDF thermal and nuclear power plants.



TO FIND OUT MORE...

- > [Guaranteeing the performance of your electric motors](#)

NYMFEA box, installation and training

On quotation

Diagnostic service

On quotation

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TESTING YOUR ROTATING MACHINES IN DISRUPTED ENVIRONMENTS

YOUR CHALLENGES

- To optimise a solution for the integration of renewable energies into networks
- To identify the impact of a strong, disrupted power supply on an electrical machine
- To approve a design: accelerated ageing tests on motors
- To approve a variable speed motor investment: to measure a motor's energy performance
- To assess diagnostic solutions on generators or motors

*R507 chiller unit on the EDF
Lab Renardières site in
Moret-sur-Loing.*

SOME OF OUR EQUIPMENT

- > 100 kW power amplifier
- > Motor test bench up to 200 kW with variable speed load machine
- > OPAL-RT real-time simulator
- > Instrumented generator to simulate faults
- > Measurement of precision power
- > Automated motor start-stop cycles

SECTORS OF APPLICATION

Electrical engineering industry/Renewable energies/Power distribution/Energy savings/Cooling/Pumping/Research & development

OUR OFFER

- Test campaigns to assess the integration of renewable energies into a network that includes rotating machines, frequency stability and voltage stability tests
- Subject your equipment to perfectly controlled disrupted power supplies, with power of up to 100 kW, and assess the functional consequences or consequences to service life
- Subject motors to accelerated ageing cycles in accordance with a controlled, automated protocol, several thousands of on-load start-ups, for example
- Measure the energy performance of industrial motorisation under conditions that are representative of its real environment
- Assess the performance of your generator diagnosis tool using our generator, which includes real and simulated faults
- Training: practical work on complex rotating machine test benches.





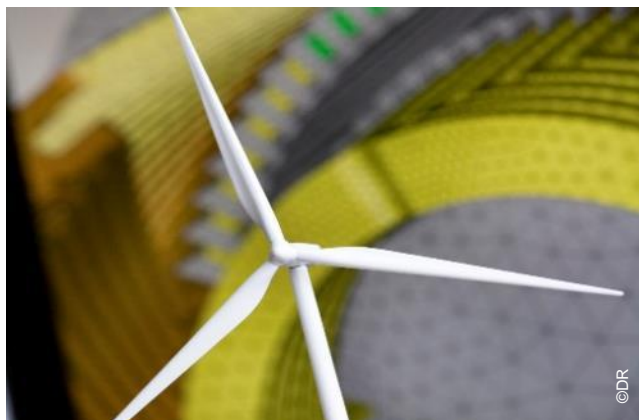
OUR STRENGTHS

- A modular test laboratory, from rotating machines to micro-networks
- A real-time simulator to produce an infinite variety of configurations
- Power supplies and load machines driven by power electronics power supplies, tests carried out in a highly automated manner
- Internationally recognised scientific excellence (publications, awards, higher education)

THEY PUT THEIR TRUST IN US

For a start-up (2016): Simulation of the performance of an innovative energy-saving system.

ADEME: Our tests have been approved by ADEME to propose Energy Saving Certificates to EDF's customers.



TO FIND OUT MORE...

- > [Protecting your equipment against electrical transients](#)
- > [Guaranteeing the performance of your electric motors](#)
- > [Improving the reliability of the rotors of your generators](#)

Training

Tailor-made training possible.

Tests and measurements

By the day, on quotation

Audits, studies

On quotation

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TRAINING, INNOVATION

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INNOVATING WITH AND FOR YOU

THROUGH DESIGN

by Innovation Hub



SECTORS OF APPLICATION

All sectors of all sizes

SOME OF OUR TOOLS

- > A team with expertise in design, able to identify and achieve breakthroughs, even in the most constrained sectors
- > All tools and methods proven to rapidly increase the maturity of an innovation
- > A collaborative area suitable for large teams

YOUR CHALLENGES

- To grasp the various changes in technologies, science and society and to convert them into resolutely innovative ideas, services, interfaces and objects that your customers can understand and use
- To rely on a research method capable of simultaneously coming up with and manufacturing these innovations **in collaboration** with your business lines, your experts, actors in the field and your customers



*I²R laboratory (breakthrough innovation incubator),
EDF Lab les Renardières, Moret-sur-Loing*

OUR OFFER

Personalised support for your teams, on your premises or within our own EDF R&D Innovation Hub laboratory. Each project benefits from a unique, tailor-made approach and combination of skills, enabling complex issues related to innovation to be solved quickly, even in very constrained contexts.

A **multidisciplinary approach** that relies on the internal teams of the various EDF R&D laboratories or on very specific external skills. We can use both digital and physical experimentation, technology and sales, hard and soft sciences, forward planning and the application approach, the start-up mindset and the experience of a large group, etc.

A **mindset that is both daring and pragmatic**, to jointly come up with, design and develop tomorrow's most breakthrough innovations, while also testing their maturity. This is carried out through:

- Tried and tested **Design** methods, inspired by the mechanisms used at the MIT in particular, which promote the expression and deployment of breakthroughs in uses, technologies, services or strategic positioning
- Resources capable of rapidly producing **proofs of concept, models or computer applications**, enabling the relevance of solutions to be quickly tested with customers or operational users





OUR STRENGTHS

A network of experts: A unique network of experts built over more than ten years of contact with EDF R&D's multidisciplinary teams and external partners who are among the most advanced in their fields. This network is continuously growing, in line with new internal or external projects.

Methods: Tried and tested working and creativity methods, taught by designers in the most prestigious French schools.

Tools: The most cutting edge digital and physical prototyping tools (3D printers/digital devices enabling the use of augmented reality/electronic prototyping kit for designing smart, communicating objects/multi-media interface prototyping software: smartphones, PCs, tablets, etc.)

A Collaborative Area: A 250 m² area at the heart of the R&D laboratories, a fully modular **Breakthrough Innovation Incubator (I2R)**, enabling project teams to take up residence for several days or even several months/adaptation to the presence of large numbers of people (5 to 40 people)/interactive and collaborative digital work tools/intellectual and material resources).

THEY PUT THEIR TRUST IN US

EDF SA (2016): Development of a range of low-cost connected objects, enabling older electric heaters to be remotely controlled (patented devices)

Luminus (2016): Development of annual heating consumption reviews

EDF SA (2016): Assistance in the development of a series of six proofs of concept for the Digital Division, concerning issues related to energy information representation and interaction

EDF SA (2015): Assistance in the strategic positioning of EDF Collectivités Territoriales for CAP 2030

EDF SA (2015): Identification and resolution of a technical issue concerning fuel loading in nuclear power plants

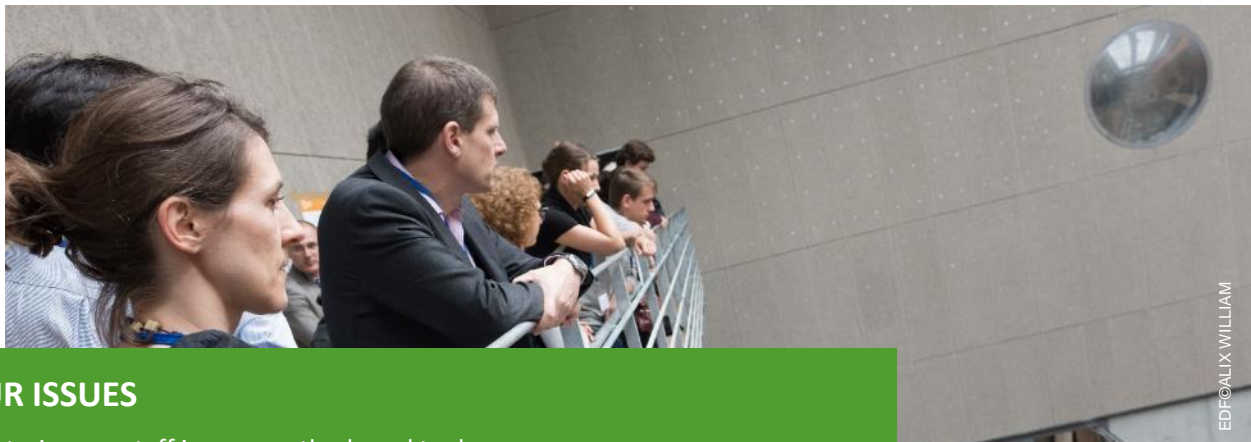


Tailor-made support, ranging from a few days to several months
(please contact us for more information)

CONTACT

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TRAINING YOUR STAFF



EDF@ALIX WILLIAM

YOUR ISSUES

- To train your staff in new methods and tools
- To deepen your knowledge of low carbon energy production business lines

Visit of a test facility during a training session on the EDF Lab Paris-Saclay site

OUR PREMISES

Training courses are organised by the Institut de Transfert des Technologies (Itech), a training organisation led by EDF R&D.

Training takes place near laboratories and test facilities on one of the [EDF R&D sites](#)

- > EDF Lab Paris-Saclay
- > EDF Lab Les Renardières, Moret-sur-Loing
- > EDF Lab Chatou

And EDF Group training Campus in Paris-Saclay (France)

Laboratory visits are organised where appropriate to the training course in question

OUR OFFER (1/4)

For each training course of 1 to 5 days, a pedagogical manager supervises the various interventions:

Business models, innovation

- The role of the facilitator in promoting collective intelligence dynamics

Fuel core, neutronics

- Neutron transport in nuclear reactors: phenomenology
- Advanced neutron transport in nuclear reactors: theory and calculations
- Theory of PWR reactor physics

Instrumentation and control, instrumentation and industrial IT

- Operational safety of programmed systems

Economy

- Smart Grids : stakes, challenges and perspectives (*NEW*)

Energy efficiency

- Energy efficiency: sectoral vision and technologies
- Introduction to the diagnosis of industrial utilities

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TRAINING YOUR STAFF

OUR OFFER (2/4)

Environment, waste

- Climate system and weather forecasts
- Air quality, stakes, regulation and perspectives (NEW)
- Atmospheric physics and dispersion modelling

Functioning of electrical systems, operation of power networks

- Insertion of renewable energies
- Standards for Smart Grids
- Introduction to [IEC 61850](#) standard
- Basic knowledge of telecoms in EDF business lines

Functioning and operation of power plants

- Introduction to [Modelica](#) modelling of energy process operation using the [DYMOLA](#) tool

Civil engineering

- Long-term management of civil engineering structures
- Durability of concrete structures in PWR power plants

Hydroelectricity

- Sedimentology in rivers and reservoirs
- TELEMAC – Module 1: basics on hydraulics and the use of SALOME and TELEMAC-2D
- TELEMAC – Module 2: construction of hydraulic model with SALOME-HYDRO
- TELEMAC – Module 3: use of TELEMAC-2D for hydraulic studies in fluvial environment
- TELEMAC – Module 4: use of TELEMAC-2D and TELEMAC-3D for hydraulic studies in maritime environment

Materials

- Materials in pressurized water nuclear reactors
- Resistance and behaviour of cementitious materials: micromechanical modelling

Electrical equipment

- Introduction to power electronics
- Understanding and interpreting electrical equipment tests

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TRAINING YOUR STAFF

OUR OFFER (3/4)

Applied mathematics

- Introduction to extreme value statistics
- Mathematical optimisation: from theory to implementation

Mechanics

- [Code Aster](#) and [Salomé Méca](#): Introduction
- [Code Aster](#) and [Salomé Méca](#): Civil Engineering
- [Code Aster](#) and [Salomé Méca](#): High Performance Computing
- [Code Aster](#) and [Salomé Méca](#): THM module

Optimisation of production and energy markets

- Understanding the gas market

Data science

- Introduction to data quality

Operational safety, security, radiological protection

- Reliability and safety of industrial systems
- Component reliability modelling: probabilistic methods, statistical methods, uncertainty analysis
- Uncertainties – Introduction: introduction to uncertainty analysis and use of digital models
- Uncertainties – Implementation: use of [Open TURNS](#) software for uncertainty analysis
- Uncertainties – Advanced: advanced methods and tools to process uncertainties for digital models
- Overall vision and benchmarks in feedback
- Use of KB3 in the context of [Probabilistic Safety Assessments](#)
- Physics of fires and use of MAGIC software

Information systems

- General architecture concepts for Information Systems

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OUR OFFER (4/4)

Thermal-hydraulics

- Local thermal-hydraulics: basics
- Local thermal-hydraulics: specific physics
- Code_Saturne – Module 1: getting started
- Code_Saturne – Module 2: advanced use and development
- Introduction to two-phase thermal-hydraulics at component level for cores and heat exchangers
- THYC component two-phase thermal-hydraulic code – Getting started

Processing scientific information

- SALOME platform - Module 1: getting started
- SALOME platform - Module 2: mesh creation using SMESH
- SALOME platform - Module 3: geometrical modelling using SHAPER
- SALOME platform - Module 4: using the ParaViS visualisation module
- SALOME platform - Module 5: using data assimilation with ADAO
- SALOME platform - Module 6: script development using ParaViS, management of mesh and fields using MEDCOUPLING
- Use of high-performance computing resources

OUR STRENGTHS

- Trainers, engineers and technicians who use expertise that is recognised both inside and outside the EDF Group. In their professional work, they alternate between theory and practice.
- Daily contact with EDF's business units enables training courses to be enriched through the addition of numerous concrete cases studies.
- Internationally recognised scientific excellence (papers, higher education).
- Thanks to its location in the Paris-Saclay Research and Innovation cluster, the Institute benefits from the latest training facilities and from the Cluster partnerships dynamics.

Are you interested in one of our training courses?

More information in the detailed catalogue



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CATALOGUE AVAILABLE ONLINE

<https://goo.gl/7npg3W>



