

THE ESSENTIALS  
2018

INNOVATING  
FOR ENERGY

[www.ifpenergiesnouvelles.com](http://www.ifpenergiesnouvelles.com)

## MEETING TOMORROW'S CHALLENGE TODAY

### **IFP Energies nouvelles**

is a major research and training player in the fields of energy, transport and the environment. From research to industry, technological innovation is central to all its activities.



THE ESSENTIALS  
2018

INNOVATING  
FOR ENERGY

# IFP ENERGIES NOUVELLES

INTERVIEW WITH **DIDIER HOUSSIN**

Chairman and CEO of IFPEN

# 2018, A KEY YEAR FOR THE TRANSFORMATION OF IFPEN



*Today, new energy and mobility technologies account for more than 50% of our research programs, which are supported by a solid bedrock of fundamental research. This rapid transformation reflects our capacity to look forward to the future, drawing on our experience and our strengths.*



## IFP ENERGIES NOUVELLES (IFPEN) IS A MAJOR RESEARCH AND TRAINING PLAYER IN THE FIELDS OF ENERGY, TRANSPORT AND THE ENVIRONMENT.

From research to industry, technological innovation is central to all its activities, structured around three strategic priorities: sustainable mobility, new energies and responsible oil and gas.

As part of the public-interest mission with which it has been tasked by the public authorities, IFPEN focuses on:

- providing solutions to take up the challenges facing society in terms of energy and the climate, promoting the transition towards sustainable mobility and the emergence of a more diversified energy mix;
- creating wealth and jobs by supporting French and European economic activity, and the competitiveness of related industrial sectors.

Consisting of world-leading industrial players and small to medium-sized companies with strong growth potential, this policy of valorisation is illustrated by the portfolio of subsidiaries and stakeholdings of the IFP Group.

An integral part of IFPEN, its graduate engineering school – IFP School – prepares future generations to take up these challenges.

Created in 1944, IFPEN is a state-owned industrial and commercial establishment.

# KEY FIGURES 2018



**€279.7 M budget**  
including **€233.4 M** for R&I

R&I activities self-funded  
to the tune of more than  
**50%**

**50%**  
of budget  
dedicated to NETs



**2 SITES**  
at Rueil-Malmaison (near Paris)  
and Solaize (near Lyon)

More than  
**600**  
scientific  
publications  
and conference  
papers



**188**  
basic patent  
applications  
including **88**  
in the field of NETs



**1,622**  
Total full-time equivalent  
workforce for 2018  
including **1,119** researchers  
(R&I engineers and technicians)



Nearly  
**200**  
research grant holders,  
post-doctoral researchers  
and trainees

Around  
**500**  
IFP School graduates



**66**  
collaborative projects  
with government  
backing involving  
IFPEN under way in 2018

Over  
**50**  
job fields

**400**  
employees have  
been mobile  
since 2015



More than  
**30**  
companies  
created by IFPEN  
since 1944



**ISO**  
**9001** -  
certified for R&I  
activities



**76%**  
of employees  
benefited from  
at least one  
training initiative in 2018



**4.86%**  
Proportion of disabled  
workers in 2018



# OUR

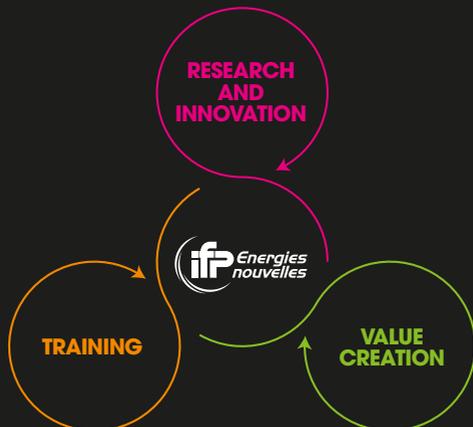
# MISSION

## A CONTEXT

CLIMATE CHANGE AND THE ENERGY TRANSITION



## THREE PRIORITY AREAS



# STRATEGIC DIRECTIONS

# DEVELOPING INNOVATIONS OF TODAY AND TOMORROW

IFPEN's commitment to the development of a sustainable energy mix is reflected in actions aimed at increasing energy efficiency, reducing CO<sub>2</sub> emissions and improving the environmental footprint of industry and transport, while meeting the global demand for mobility, energy and products for the chemicals sector. To achieve these objectives, IFPEN has hinged its R&I activities around three strategic priorities supported by fundamental research.

## SUSTAINABLE MOBILITY

Reducing CO<sub>2</sub> and pollutant emissions, diversifying energy sources and incorporating the evolution in transport modes: these are the challenges associated with sustainable mobility. IFPEN channels its expertise into addressing this triple challenge via the IFPEN Transports Energie Carnot Institute. This Institute is exploring three complementary technological avenues, namely vehicle electrification (from the hybrid to the electric vehicle), the development of services and applications for connected vehicles and, lastly, the improvement of IC engines, with a view to improving energy efficiency, reducing emissions and optimizing the use of fuels, particularly low-carbon fuels.



## NEW ENERGIES



The energy transition and tackling climate change depend, among others, on the use of new resources such as lignocellulosic biomass and offshore wind energy, the potential of which is set to expand. IFPEN develops sustainable fuel and chemical intermediate production processes based on the use of biomass, as well as technological solutions for the development of ocean energies. IFPEN also proposes energy storage technologies. In addition, with a view to reducing greenhouse gas

emissions at source, IFPEN is conducting research to improve CO<sub>2</sub> capture and storage processes. Lastly, IFPEN is investing in new themes such as geothermal energy, rare earths and critical metals, as well as environmental monitoring.



## RESPONSIBLE OIL AND GAS

Today, the oil and related industries are undergoing some profound transformations. Against the backdrop of the accelerating energy transition, the sectors must significantly reduce their environmental footprint while continuing to meet sustained demand in the short and medium terms. IFPEN develops eco-efficient and flexible processes for the production of fuel, hydrogen and chemical intermediates meeting the strictest standards. In addition, IFPEN is developing increasingly efficient and cleaner, cutting-edge technologies for oil and gas exploration and production.

## FUNDAMENTAL RESEARCH SERVING INNOVATION

In order to facilitate the emergence of its innovations and ensure the scientific excellence of its research activities, IFPEN deploys an original research strategy hinged around a solid fundamental research program. Organized around nine specific scientific issues, the program represents a cross-functional bedrock aimed at addressing scientific questions associated with the development of new products and processes. To this end, IFPEN maintains a dynamic ecosystem of academic partnerships and is involved in numerous French and European collaborative research projects.



# CREATING WEALTH AND JOBS

IFPEN's economic model is based on the transfer to industry of the technologies developed by its researchers. This technology transfer to industry generates jobs and business, fostering the economic development of fields and approaches related to the mobility, energy and eco-industry sectors.

## A CULTURE OF INNOVATION

The success of IFPEN's value creation model depends on its capacity to deliver innovations, via the development of a forward-looking vision of its activities and the production of research in line with the needs of the energy market. IFPEN has also equipped itself with the organizational structure, methods and tools it needs to detect new opportunities and to take into account the potential for the market development of the targeted products and services right from the outset of projects.

## A COLLABORATIVE RESEARCH STRATEGY

Since the challenges of the energy transition go far beyond the scientific and technological expertise of a single body, because pooling knowledge, know-how and costs creates synergies and accelerates the innovation process, because developing new industrial processes depends on the involvement of all the players, IFPEN builds strategic partnerships with academia and industry, throughout the innovation chain.

## FROM RESEARCH TO INDUSTRY

IFPEN's innovations are brought to market through close partnerships with industrial players and IFP Group subsidiaries, that include benchmark global players and young innovative companies. In addition, IFPEN creates firms or acquires shareholdings in innovative companies, and supports the development of start-ups, SMEs and intermediate-sized companies.

# TRAINING THE KEY PLAYERS IN THE ENERGY TRANSITION

Against the backdrop of the energy transition, IFP School and IFP Training provide industry with the highly qualified personnel it requires to take up current and future technological, economic and environmental challenges. IFP School operates within a highly international environment and provides young graduate engineers with advanced graduate programs in the fields of energy, motor vehicles and the environment. Over 500 students from throughout the world graduate from IFP School each year. IFP Training, an IFPEN subsidiary, offers training courses to almost 15,000 employees from industry every year, securing their competitiveness.

## IFP SCHOOL

IFP School has a dual ambition: to provide industry with the skills it needs today and to train the future energy transition players. For this, it is supported by a strategic ecosystem of leading academic and industrial partners, offering its students a cutting-edge teaching model, hinged around innovative materials and tools. Thanks to the skills acquired, IFP School graduates are immediately operational in their sector and already prepared for the jobs of the future in the field of new energy technologies (NETs).

## IFP TRAINING

IFP Training trains the operators, technicians, managers, engineers and leaders of the oil and gas, chemicals and powertrains sectors. A shareholder in Corys, the global dynamic process simulation leader, IFP Training provides a unique global solution combining high fidelity, generic or specific simulators, and programs leading to a qualification, aimed at improving the performances and safety of teams in the field.





# SUMMARY

## HIGHLIGHTS 2018

# HIGHLIGHTS

**IFPEN 2018 NEWS IN BRIEF**

**SUSTAINABLE MOBILITY**

**NEW ENERGIES**

**RESPONSIBLE OIL AND GAS**

**FUNDAMENTAL RESEARCH  
SERVING INNOVATION**

**CREATING WEALTH AND JOBS**

**TRAINING THE KEY PLAYERS  
IN THE ENERGY TRANSITION**

# IFPEN 2018 NEWS IN BRIEF

## IFPEN SERVING THE TERRITORY

At the end of 2018, IFPEN joined forces with the town of Rueil-Malmaison and Paris Ouest La Défense to sign a framework partnership agreement aimed at serving the local region and its residents through development and innovation. This agreement consolidates existing partnerships and defines strategic development priorities with a view to making the region an innovation pioneer. Joint projects will be conducted in the fields of the energy and ecological transition, sustainable mobility, entrepreneurship and digital technology.



## IFPEN'S CONTRIBUTIONS TO PUBLIC POLICIES

IFPEN took part in the reflection processes and helped to draft the French Energy and Climate Strategy, presented at the end of 2018 by the Government. In particular, its contribution related to biofuels, clean mobility and carbon pricing. IFPEN also took part in the public debate organized within the context of the French long-term energy program (PPE) via several workshops and the publication of a guide relating to biofuels. In addition, in view of the review of France's draft framework legislation on mobility (LOM), IFPEN's experts were called upon by various National Assembly and Senate bodies to provide insights relating to the themes of clean mobility, advanced biofuels and the end of IC vehicles by 2040.



## ENER220: THE NEW SUPERCOMPUTER SERVING INNOVATION

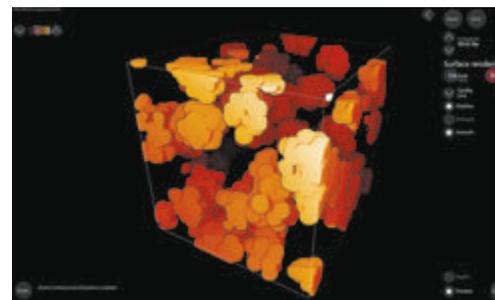
In August 2018, IFPEN commissioned a new supercomputer to address the fast-evolving needs of R&I teams in the fields of numerical simulation and high-performance computing. Replacing ENER110 at the IFPEN-Lyon site, this major piece of scientific equipment has double the power of its predecessor and complements the external computing resources researchers have access to through partnerships with leading French bodies.

## RENEWABLE ENERGY GEOPOLITICS

At the end of the year, in the context of the ANR Generate (*Geopolitics of Renewable Energies and Prospective Analysis of the Energy Transition*) project launched at the start of 2018, IFPEN and its partner IRIS\* published the results of a prospective study on the evolution of energy geopolitics in the context of the low-carbon transition. Firstly, the study underlines the evolution from reliance on fossil resources towards other types of resources. It also highlights the strategic role of innovation in renewable energy technologies. Lastly, it reveals the impact of the price of fossil energies on the development of these technologies and, consequently, the influence of oil and gas-producing countries on the energy transition.

\* French Institute for International and Strategic Relations

## THE DIGITAL TRANSFORMATION AT IFPEN: A STRATEGIC PRIORITY



An ambitious action plan was launched in 2018. It is hinged around a functional dimension, aimed at improving the organization's overall performance, and a dimension concerning the structuring of R&I programs to develop new products and reinforce IFPEN's digital offer. For example, the Plug Im! platform, providing non-expert users with access to 2D and 3D signal and image processing, was launched on an open access basis aimed at the scientific community. In addition to the fields already covered by IFPEN's R&I activities, such as services for connected vehicles, numerous proofs of concept (POC) and projects were

developed incorporating cross-disciplinary digital tools, methodologies and approaches. Examples include the wind turbine digital twin in the field of new energies; or, in the field of processes, new monitoring platforms improving the predictive capabilities of simulators.

# SUSTAINABLE MOBILITY



**25%**

of global energy demand is related to the transport sector

## MEETING MOBILITY SECTOR PLAYERS

The IFPEN Transports Energie Carnot Institute forges relations with start-ups, SMEs and intermediate-sized companies operating in the car and mobility sectors at various events it either organizes or takes part in. The objective: to help these companies gain access to R&I support specific to their innovation need. In 2018, it:

- presented its latest innovations in the vehicle sector at the Global Industrie conference, in March, as well as in the aeronautics field;
- took part in the annual "17-20 Carnot" event, in May, on the theme "Carnot: an international ambition";
- met project leaders interested in its sustainable mobility services and solutions, at the 11<sup>th</sup> edition of the Carnot events held in Lyon in October.

## TOWARDS A NEW RANGE OF ELECTRIC MOTORS

IFPEN is developing a range of electric motors with their power electronics, covering the needs of every market segment. Following a first version for small, no-license vehicles and a second one for urban cars, a synchronous reluctance electric machine or HSM (Hybrid Synchronous Motor) prototype was developed in 2018 for compact cars applications. Innovations with respect to the active parts of the machine and the mechanical integration of the system, with an inverter and a DC/DC converter directly incorporated in the motor housing were introduced. Advanced control laws were also developed for this application. The result is improved system efficiency and a significant reduction in costs.

## INSIGHT CONCERNING VEHICLE ELECTRIFICATION



Working in partnership with ADEME, IFPEN analyzed the major trends and potential relating to vehicle electrification in France from the point of view of energy, economics and the environment. Published in July 2018, the E4T study identifies the best technological choices as a function of usages by 2030. In particular it highlights:

- the significant slowdown expected in the production of gasoline and diesel vehicles by 2030 (excluding long haul trucks);
  - the ecological relevance of plug-in hybrid vehicles for private individuals in the medium term;
  - the efficiency of electric vehicles in terms of reducing local pollution and CO<sub>2</sub> emissions, like buses.
- A follow-up to this study, projecting forward to 2040, will be launched in 2019. This study will evaluate hydrogen, biofuel and natural-gas based energy systems.

## GECO AIR, A PUBLIC DECISION-MAKING TOOL



Geco air, the smartphone app that estimates a vehicle's real-time pollutant and CO<sub>2</sub> emissions, is gaining in popularity among local authorities and air quality players. Recent developments are opening up new avenues by making it possible to visualize and understand the impact of urban infrastructure on vehicle pollution. Two experiments were launched in 2018, in the Auvergne-Rhône-Alpes region with Lyon Metropolis and in the South with Aix-Marseille-Provence Metropolis. Their aim is to draw up a detailed, real-time map of pollutant emissions across a region, by analyzing data provided by users. Initially designed to help users become "eco-mobility drivers", the

Geco air app now facilitates local authority decision-making concerning urban planning, road development and traffic management.

## TOWARDS HIGHLY-EFFICIENT GASOLINE ENGINES

**95 g/km**

average CO<sub>2</sub> emissions objective set by the European Union for new vehicles by 2021

In order to improve the thermodynamic efficiency of gasoline powertrains operating with a stoichiometric mixture, IFPEN has developed and optimized a new generation of combustion systems using an original swumble-type internal aerodynamic approach. Having been demonstrated on a 1 liter - 3 cylinders - 2 valves per cylinder powertrain in 2017, this approach was successfully transferred to a 4 valves per cylinder engine in 2018. A maximum effective efficiency of 43% and efficiencies in excess of 37% over a broad operating range were achieved, while significantly reducing particulate emissions across the emission spectrum.

## NEW TOOL FOR MEASURING THE THERMAL STABILITY OF JET FUELS



IFPEN and its partner AD Systems developed a device used to characterize the thermal stability of fuels for the aviation industry, a major problem stemming from the use of new combustion systems and fuel diversification. Called TO10 and launched to market by AD Systems at the end of 2018, the instrument is currently being approved by the ASTM. It incorporates models developed by IFPEN describing the thermal stability of jet fuels.

# NEW ENERGIES

## THE FUTUROL PROCESS: MARKET LAUNCH!

After 10 years of research, the French Futurol project targeting the development of a 2<sup>nd</sup> generation bioethanol production technology was successfully completed at the end of 2018. IFPEN was a key player in this collaborative project. Futurol technology has now entered the marketing phase, which will be handled by Axens. Presenting a more favorable environmental footprint than that of 1<sup>st</sup> generation processes, this solution is also economically competitive and adapted to different types of biomass, ensuring it can be continuously used anywhere in the world.

**14%**

The potential contribution of CCUS to the reduction in CO<sub>2</sub> emissions by 2060 (the IEA Blue Map scenario)

## PRODUCTION OF BIO-AROMATICS: EXCELLENT RESULTS FOR THE BIO-TCAT™ PROCESS PILOT UNIT

In 2015, IFPEN, Axens and Anellotech joined forces to develop Bio-TCAT™, a process for the thermocatalytic conversion of lignocellulosic biomass with a view to the competitive production of bio-aromatics. In March 2018, a continuous test was conducted over a period of 14 days on the TCat-8® pilot unit installed at Anellotech's Silsbee site in Texas. The test validated the technologies and the pilot unit's process control, and demonstrated its highly efficient operation. The acquisition of the operational data required for the industrial scale-up of the process continued throughout the year, alongside research focusing on biomass pre-treatment.



## TOWARDS NEW LITHIUM EXTRACTION AND CAPTURE SOLUTIONS

In order to optimize the use of existing lithium resources with a reduced environmental footprint, IFPEN and its partner Eramet developed an innovative and competitive direct extraction process, adapted to the waters of the Argentinian salt flats and producing a more concentrated form of lithium with a very high purity (> 99%). The selective adsorbent technology is based on was validated in conditions representative of the process in July 2018, following six months of continuous operation of a semi-industrial pilot unit at Eramet Ideas' Trappes (France) site. The lithium that will be produced by Eramet from 2021 will meet the needs of the battery market for electric vehicles and mobile devices as well as those of the glass and ceramics production sectors.

## WIND TURBINE 4.0: PROMOTING INNOVATIVE SOLUTIONS

In June 2018, IFPEN hosted a design thinking workshop on the theme "wind turbine digital twin". The digital twin is the virtual version of a product or object, used to simulate and predict its operation. The purpose of this two-day creative process was to work with customers and potential partners to design a digital solution for wind turbines aimed at optimizing their operation and maintenance. More than twenty participants were mobilized: energy companies, sensor suppliers, turbine suppliers, maintenance and safety specialists, as well as IT professionals. The workshop was brought to a successful conclusion with a collective pitch before a panel of investors. Following the considerable interest shown in this initiative, IFPEN will host another workshop dedicated to digital twin applications, in 2019.

**10 times lower**

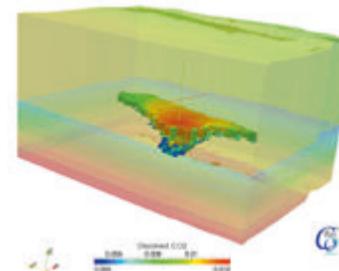
levels of greenhouse gas emissions with advanced biofuels compared with the fossil reference

## IFPEN MICROGRID: ELECTRICITY STORAGE SYSTEM TESTING

For the purposes of its research concerning stationary energy storage systems, IFPEN has constructed a Redox flow battery demonstrator integrated in a microgrid at its Lyon site. Launched in August 2018, this demonstrator consists of a photovoltaic panel, an electric vehicle charging point and an electricity storage system. The objectives are, firstly, to be able to test the properties and battery use limits in a representative environment and, secondly, to validate energy management systems (EMS) that manage and optimize the storage operation and make it possible to integrate variable amounts of electricity of solar or wind origin into the network.



## TOWARDS AN INTEGRATED SOLUTION FOR CO<sub>2</sub> STORAGE MODELING



In 2018, IFPEN finalized the first version of the CooresFlow prototype, a new generation software for the combined simulation of fluid-rock interactions from basin to well scale, particularly adapted to problems associated with CO<sub>2</sub> storage. The software incorporates features making it possible to model storage facility behavior and prevent risks during the storage site selection and design phases, simulate the future of the CO<sub>2</sub> stored, help position monitoring tools during the surveillance phase and adapt the measurement protocol.



# RESPONSIBLE OIL AND GAS

## A NEW VACUUM DISTILLATE CONVERSION PROCESS VIA HYDROCRACKING

In 2018, IFPEN and Axens finalized a new vacuum distillate conversion process via hydrocracking. It hinges around an intensification of the process design, with a view to improving its performance and environmental footprint. This innovation addresses the flexibility requirements of the hydrocracking market, in that the process can be adapted depending on the target products: diesel fuel, kerosene or petrochemical bases. It makes it possible to achieve target parameters in terms of conversion, middle distillate selectivity and product quality. Constraints with respect to feeds, operating conditions and cycle time are more effectively taken into account.

**25%**  
of a refinery's flow is treated  
by the FCC process

## NEW GENERATIONS OF CATALYSTS FOR SELECTIVE HYDROGENATION PROCESSES



Steam cracking is a key element for the production of olefins such as ethylene (C2 cut) and propylene (C3 cut), and naphtha (pyrolysis gasoline cut). To be used, these cuts need to be purified. Processes and catalysts developed by IFPEN in partnership with Axens make it possible to selectively hydrogenate them in order to achieve impurity contents of less than 1 ppm. In 2018, thanks to the development of a new palladium-based catalytic phase and optimized support preparation, IFPEN created two new generations of more effective selective hydrogenation catalysts:

- for the "pyrolysis gasoline" cut, a new catalyst that offers improvements in terms of activity, stability and lifespan. This makes it possible to obtain the same performance as the previous generation but at a lower temperature, significantly reducing the unit's energy consumption, with longer life cycles and lifespans;
- for the "propylene" cut, a new catalyst presenting enhanced activity and selectivity as well as improved stability with respect to operating condition variations, and a broader range of operating conditions.

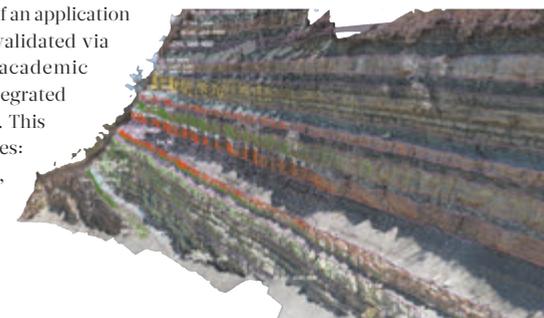
## ARCADES, NEW DIONISOSFLOW CALCULATOR

Resulting from IFPEN's research and marketed by Beicip-Franlab, the DionisosFlow stratigraphic modeling software solution is designed to more accurately describe sedimentary layer deposits on a regional scale, thereby reducing exploration or delineation risks. In the longer term, the solution will contribute to the evaluation of the impact of climate change on sedimentary systems, particularly on soils and coasts. The 2018 version of DionisosFlow incorporates a new calculator, ArcaDES, developed by IFPEN, on the basis of the Arcane platform co-developed with the French Alternative Energies and Atomic Energy Commission (CEA). The innovation improves the robustness and accuracy of calculations, and improves overall performance (parallel version). ArcaDES will now be used within the framework of future JIPs (Joint Industry Projects) and collaborative projects, particularly the DORS 2 JIP on the modeling of organic matter production, decomposition and preservation, and the CarDIO JIP set up to model the transformation of sediments (carbonates) in rocks under the effect of diagenetic processes.

**35%**  
The average recovery rate  
from fields globally

## TOWARDS THE 3D INTERPRETATION OF GEOLOGICAL OUTCROPS

For several years now, IFPEN has been active in the digitalization of geosciences via a package of technologies integrated in the SmartAnalog workflow. SmartAnalog is used to work on geological outcrops comparable to buried reservoirs, containing energy resources (water, CO<sub>2</sub>, hydrocarbons, etc.). One of the technologies associated with the workflow and stemming from IFPEN's R&I, Virtuoso, is used to analyze and interpret models of outcrops reconstructed in 3D from photos taken on the ground. It is a prototype of an application under development since 2013 and validated via a series of tests conducted with academic partners. A stabilized version was integrated in the SmartAnalog workflow in 2018. This technology addresses three objectives: propose a didactic tool for field geology, calibrate the parameters for reservoir simulation and conduct 3D virtual tours of outcrops.



<https://www.smartanalog.eu>

# FUNDAMENTAL RESEARCH

## SERVING INNOVATION

### PLUG IM!: SIGNAL AND IMAGE PROCESSING AVAILABLE ON AN OPEN ACCESS BASIS

Designed by IFPEN and freely available to the scientific community and industry, plug *im!* is a modular platform providing non-expert users with access to 2D and 3D signal and image processing. Bringing together data processing modules developed by IFPEN, as well as those of industrial and academic partners, it can be enhanced over time by the scientific community. Specific developments can also be accommodated by IFPEN when requested by industrial partners, to support their innovation projects.

<https://www.plugin.fr>

### RENEWAL OF THE FRAMEWORK AGREEMENT WITH THE CNRS



In 2018, IFPEN and the CNRS signed a new five-year framework agreement defining the general principles governing their collaboration, particularly research projects and the organization of joint theses and post-doctoral activities. Today, IFPEN and the CNRS launch between 20 and 30 theses and post-doctoral research activities together per year. In addition, IFPEN's teams are actively involved in around twenty CNRS research groups, including three new ones launched in 2018. The objective of the

new framework agreement is to further reinforce the collaboration with the launch of the CARMEN (*CAR*actérisation des *MAT*ériaux pour les *É*nergies *N*ouvelles, Characterization of Materials for New Energies) joint research laboratory in 2019.

### CORROSION CONSORTIUM: PROMISING RESULTS

IFPEN, the Institut de la corrosion de Saint-Étienne (French Corrosion Institute in Saint-Étienne) and six industrial partners joined forces for the Oxygen JIP (*Joint Industry Project*), which was completed at the start of 2019. The consortium evaluated the impact of oxygen traces on steel corrosion in the presence of  $H_2S$ , a fundamental issue concerning oil and gas transport. The research conducted now also makes it possible to anticipate steel corrosion and fracture risks in fields such as geothermal energy and biogas. The JIP's success has given rise to two new research proposals in partnership with the corrosion institute. One of which is aimed at understanding the effects of high pressures on steel fracture risks in the presence of  $H_2S$  (fugacity effects).

# 18

active academic collaboration  
framework agreements  
at the end of 2018

### RESEARCH FOCUSING ON ENERGIES OF THE FUTURE

Within the framework of the Cataphot project, IFPEN is conducting research to develop and optimize catalysts for the production of energy from low-carbon energy sources. For example, IFPEN is thus working with several partners to develop catalytic materials for solar fuel production. These catalysts make it possible to convert  $CO_2$  into usable molecules via solar radiation. Another example is the MoSHy project, conducted in partnership with ENS Lyon and the Grenoble LEPMI (Electrochemistry and Physical Chemistry of Materials and Interfaces) laboratory, which concerns the development of a method for identifying electrocatalysts for hydrogen production via the electrolysis of water.



### AURÉLIE PIRAYRE, WINNER OF IFPEN'S 2018 YVES CHAUVIN THESIS PRIZE

In 2018, the Yves Chauvin thesis prize was awarded to Aurélie Pirayre for her thesis entitled "*Reconstruction and Clustering with Graph Optimization and Priors on Gene Networks and Images*". The work led to the development of mathematical models enabling the more effective use of biological data, with the translation, in graph form, of the reaction cascades between *Trichoderma reesei* (a fungus the enzymes of which are used as biocatalysts in certain 2<sup>nd</sup> generation bioethanol production processes) genes.

# 166

publications by IFPEN researchers in peer-reviewed  
international scientific journals in 2018

### AWARD WINNERS IN 2018...

- Céline Pagis, recipient of the 2018 L'Oréal-UNESCO "For Women in Science" fellowship;
- Céline Chizallet, young researcher prize awarded by the Catalysis Division of the Société chimique de France (French Chemistry Society);
- Olga Vizika-Kavvadias, 2018 Darcy prize awarded by the Society of Core Analysts;
- Alexandre Letteron, former IFPEN PhD student, thesis prize from the Association des géologues du Sud-Est (South-East Geologists Association);
- Xavier Mangenot, former IFPEN PhD student, Van Straelen thesis prize, awarded by the French Geological Society.

In addition, Hélène Olivier-Bourbigou, women scientist of the year in 2014, was elected member of the Académie des technologies (French Academy of Technologies).



# CREATING WEALTH AND JOBS

**> 50%**  
of IFPEN resources come from the industrial development of its research

## THE CHALLENGES OF AIR POLLUTION ABATEMENT

Air pollution has significant impacts on health and the environment, and generates considerable economic costs for society as a whole. Improving air quality has thus become a major priority for the public authorities. IFPEN decided to open a new theme within its internal incubator in July 2018, dedicated to improving inside and outside air quality. The objective is to identify new innovation opportunities in a field of the future in which IFPEN has not really been an active player to date. An initial analysis phase was conducted in 2018 to precisely segment the different markets. This phase will make it possible to determine unmet or poorly met technological needs over the next five to ten years, as well as the associated technological challenges, all of which represent potential innovation opportunities for IFPEN. The most promising and relevant of them with respect to the expertise of IFPEN's research teams will then be examined within the framework of the incubator.

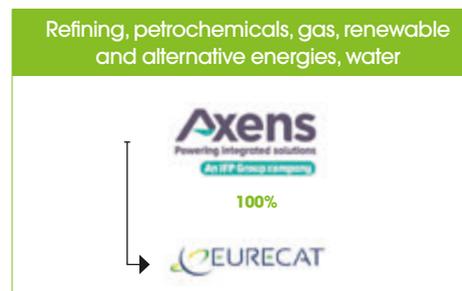
## IFPEN TAKES A STAKE IN GALANCK

In October 2018, IFPEN became a 23% stakeholder in the start-up company Galanck. Founded in 2017, Galanck designs, produces and markets connected objects related to soft mobility. The start-up developed an intelligent backpack, the Galuchon, designed for the safety and comfort of cyclists and fans of new urban transport modes (scooters, personal transporters, etc.). This stakeholding reinforces IFPEN's positioning in the connected mobility and IoT (Internet of Things) markets. Several joint development priorities have also been identified. In addition, alongside Geovelo and the start-up K-Ryole, IFPEN and Galanck submitted a project proposal within the context of an Île-de-France regional call for projects to develop the use of bicycles in urban areas.



## PORTFOLIO OF INDUSTRIAL STAKEHOLDINGS

at 30 April 2019





# TRAINING THE KEY PLAYERS IN THE ENERGY TRANSITION

## EVOLVING PROGRAMS WITH AN INCREASING FOCUS ON TOMORROW'S MOBILITY

In order to adapt its teaching provision to the acceleration in vehicle electrification and the development of connected and driverless vehicles, in 2018, IFP School defined changes in its graduate programs in the fields of sustainable mobility and powertrains. As a result, there is an increase in specific teaching on electric and hybrid powertrains within the Powertrain Engineering and Energy and Powertrain programs, as well as new teaching modules within the Energy and Products program: batteries and electromobility, gas, electricity and the digitalization of energy in industry.

**17**  
graduate programs,  
including 8 taught  
in English

## NEW INTERNATIONAL PROGRAMS

In 2018, IFP School and the National University of Singapore finalized the content for the Petroleum Projects and Offshore Technology joint master's program. The course, which will be launched in Singapore in September 2019, will cover the fields of petroleum engineering and offshore technologies. In 2018, IFP School also renewed its cooperation agreement with the Petroleum and Petrochemical College of Chulalongkorn University. The two institutions will thus continue to collaborate within the framework of the Thai university's Petroleum Technology and Energy master's program, and the partnership may be extended to include petrochemicals.

## SUCCESS OF THE NEW TOMORROW'S MOBILITY MOOC

**75%**  
of those taking part in IFP School's  
Tomorrow's mobility MOOC said they  
were "extremely satisfied"

In November 2018, IFP School launched a new free MOOC, in partnership with IFP Training and Vedecom. Called Tomorrow's mobility: sustainable technologies for the car sector, this online course enabled participants to acquire knowledge about the legislative and environmental framework governing future technological evolutions, as well as the advantages and limitations of different electric and hybrid powertrains, thanks in particular to virtual reality and serious games. The MOOC enjoyed considerable success, bringing together close to 5,000 participants for a completion rate of 20%, well above the average for MOOCs in the world.



**IFP Energies nouvelles**  
1 et 4, avenue de Bois-Préau  
92852 Rueil-Malmaison Cedex  
Tel.: + 33 1 47 52 60 00

**IFP Energies nouvelles-Lyon**  
Rond-point de l'Échangeur de Solaize  
BP 3 – 69360 Solaize  
Tel.: + 33 4 37 70 20 00

[www.ifpenergiesnouvelles.com](http://www.ifpenergiesnouvelles.com)

Find IFPEN and IFP School on the social networks



Writing: IFPEN

Design and layout: Communication

Realisation: AtelierTypao

Copyrights: AD Systems, Adobe Stock, Carl Diner pour la Fondation L'Oréal, Florian Grout/DP Multimédia, Galanck, IFPEN, IFP School, X.

Printing: this document has been printed on FSC® certified paper 

150719. IFP Energies nouvelles

All rights reserved.