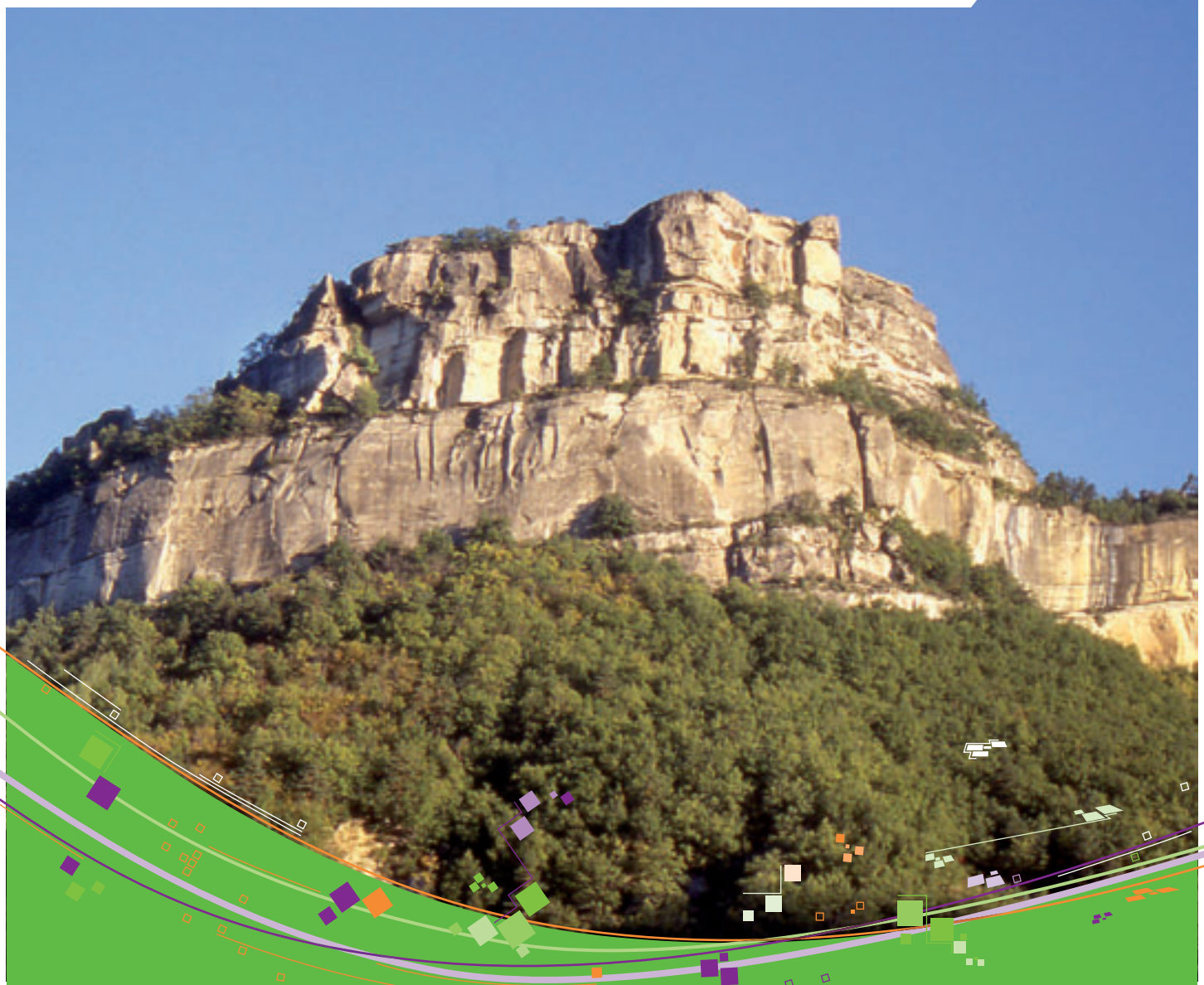
Renewable energies | Eco-friendly production | Innovative transport | Eco-efficient processes | Sustainable resources



Exploration and Production at IFP Energies nouvelles

50 years of R&D and international partnerships with industry

IFP Energies nouvelles

IFP Energies nouvelles is a public-sector research, industrial innovation and training center. Its mission is to develop efficient, economical, clean and sustainable technologies in the fields of energy, transport and the environment.

To fullfil its mission, three of IFP Energies nouvelles' priorities are:

- **Producing energy while mitigating the environmental footprint**
  Since industrial activities generate CO_2 emissions and use water resources, IFP Energies nouvelles develops CO_2 capture, transport and geological storage processes to combat global warming. It also works on technologies aimed at optimizing industry's use of water.
- **Providing environmentally-friendly technologies and pushing back the current boundaries of oil and gas reserves**
  In order to secure long-term energy supplies, the exploitation of oil and gas resources remains crucial. While working to develop oil substitutes, IFP Energies nouvelles perfects advanced simulation tools geared towards gaining an insight into the underground environment as well as environmentally-friendly technologies with a view to pushing back the current boundaries of oil and gas exploration and production.
- **Producing fuels, chemical intermediates and energy from renewable sources**
  In order to tackle the greenhouse effect causing climate change and alleviate the transport sector's reliance on oil, IFP Energies nouvelles works on the production of biofuels, chemical intermediates and energy via the transformation of biomass. It also designs the technological solutions required to harness marine resources.

Exploration and production at IFP Energies nouvelles

50 years of R&D
and international partnerships with industry

IFP Energies nouvelles has built up a network of partnerships with oil, gas and related industries around the globe. It regularly works with more than a hundred partners from the upstream oil sector in some twenty countries. It provides these partners with the services of its multidisciplinary R&D teams, which incorporate more than 300 exploration-production engineers, the majority of them holding PhDs, and highly specialized technicians, along with unique and high-performance equipment and testing facilities.

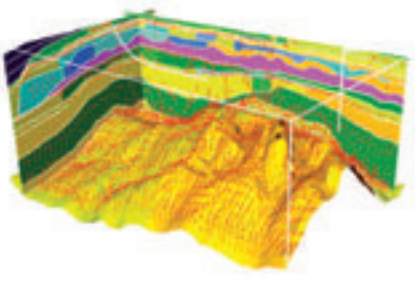
From oil and gas exploration to CO_2 capture and storage

Basin characterization and modeling

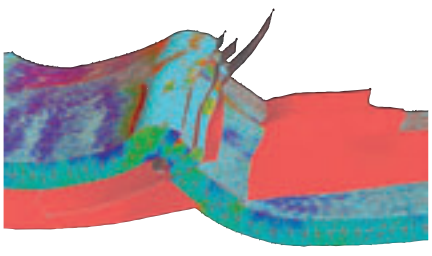
IFP Energies nouvelles, a leader in the field of basin modeling, offers software, equipment and expertise to industry. Already successfully used in difficult zones such as the Gulf of Mexico, these tools help optimize the evaluation of petroleum systems and reduce uncertainties and risks relative to the future exploitation of hydrocarbons.
The latest developments concern basin modeling in complex structural settings, such as thrust belts and salt diapirs (TemisFlow*). They are supported by new software providing 3D capabilities for palinspastic reconstructions (Kine3D) and sedimentological modeling (Dionisos).

To meet the new challenges of exploration, IFP Energies nouvelles has launched the TemisFlow* software that is marketed by Beicip-Franlab. TemisFlow offers new-generation petroleum system modeling capabilities for:

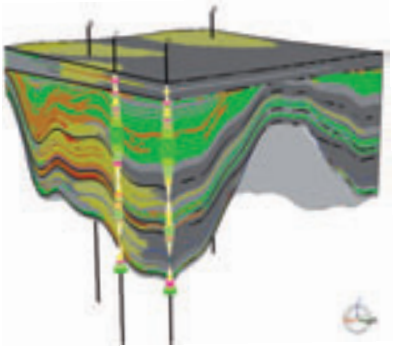
- structurally complex geological histories in extensional and/or compressional salty contexts,
- streamlined processes, for an improved understanding of physical processes to reduce uncertainties,
- greater cross-disciplinary integration and accuracy for simple and complex geometries.



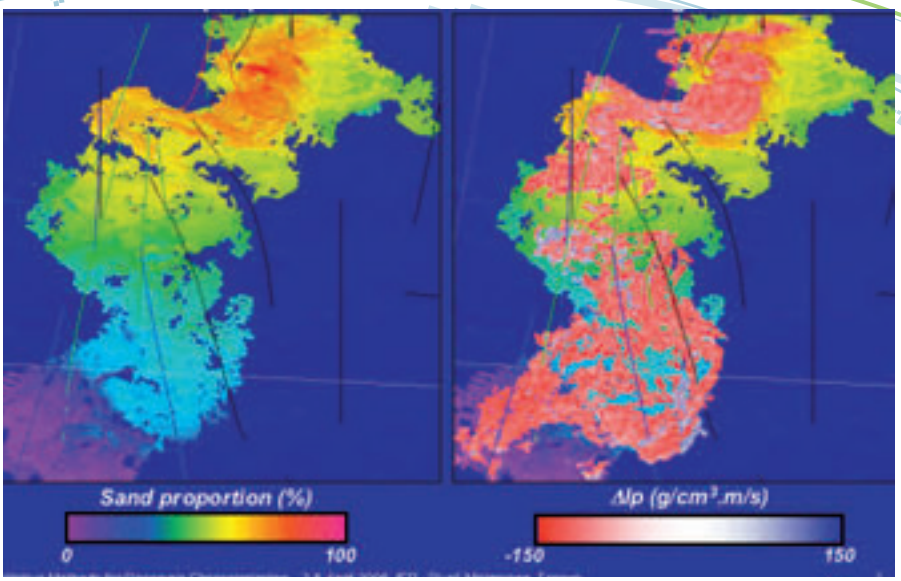
TemisFlow



Kine3D



Dionisos



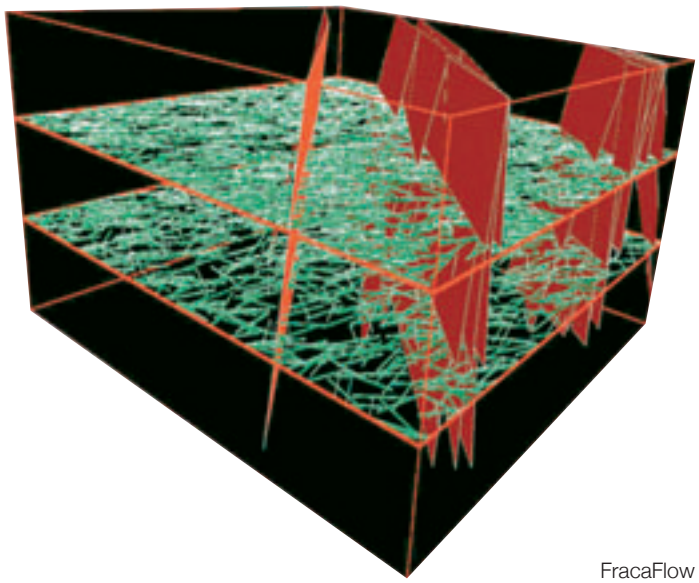
4D seismic constraint for history matching of Girassol field (Total/IFP Energies nouvelles EAGE 2006).

Enhanced oil and gas recovery

Focusing on the need to continuously increase oil and gas reserves, IFP Energies nouvelles proposes innovative techniques through a fully integrated workflow for enhanced reservoir characterization and recovery optimization, including:

- stratigraphic inversion,
- advanced fracture modeling,
- high performance numerical methods from geostatistics, upscaling and fluid flow simulations,
- accurate well productivity and injectivity modeling, providing solutions for impairment prediction or remediation with optimal treatments,
- enhanced oil recovery (EOR) innovative process,
- integration of production data and 4D seismic on both static and dynamic models for a better prediction of EOR efficiency,
- uncertainties propagation and risk analysis along the whole workflow.

At IFP Energies nouvelles, physical concepts are systematically calibrated by laboratory measurements, validated in the laboratory, validated at field scale through bilateral contracts and JIPs with oil companies, and finally introduced in commercial software and product solutions.



FracaFlow

Simulating complex reservoirs in their entirety: PumaFlow*, FracaFlow*

PumaFlow and FracaFlow new generation software, marketed by Beicip-Franlab, make it possible to characterize complex reservoir, including fractured ones, through high performance static and dynamic modeling process, to calibrate models by production and 4D seismic data using the CondorFlow methodology and to optimize production through simulation of innovative EOR processes for optimal recovery.

* TemisFlow™, PumaFlow™, FracaFlow™ and CondorFlow™ are trademarks marketed by Beicip-Franlab.

GOwSP gas-oil-water separation platform at Lyon site.

Developing and exploiting reserves

IFP Energies nouvelles is developing solutions to optimize oil and gas flows from the reservoir to the process facilities in production networks.

- A new generation of Flow Assurance simulation tools is being developed; it will also accept external models that can be easily plugged in.
- Experiments on shut-down, restart, wax and hydrate control with real fluids in field conditions are conducted in the Lyre loop testing facility.
- IFP Energies nouvelles has developed an industrial size platform including a closed-loop facility operating with gas, crude oil and water, dedicated to three phases separation studies and equipment tests (GOwSP).
- To improve the exploitation of ultra-deep water fields and heavy crudes, IFP Energies nouvelles is focusing on several areas such as riser systems, flexible and reeled pipes, thermal insulation.
- In the field of natural gas production, IFP Energies nouvelles is developing innovative industrial processes for sweetening very sour gas and dealing with the associated impurities.

Deeplines™ integrated software to design risers, moorings and flowline, marketed by Principia.

Drilling very deep offshore fields using Clip Riser®

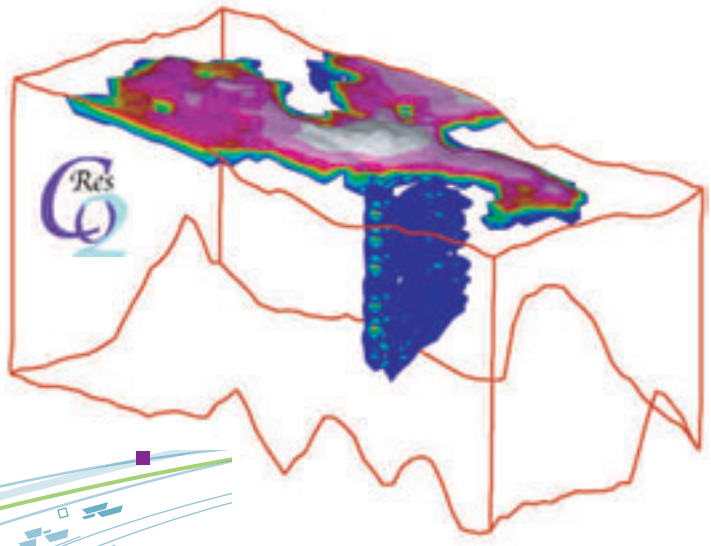
Clip Riser®, marketed by Aker Drilling Risers, makes it possible to drill at depths of 3,000 m of water. The maneuver time is reduced as a result of its rapid connector and it is entirely safe. This solution is rapidly adopted by the market. Ongoing developments aim to reduce its mass so that it can be used from lighter floating supports, making it possible to drill at even greater water depths.

Capturing and storing CO_2 to combat the greenhouse effect

IFP Energies nouvelles relies on its knowledge in the development of industrial processes for refining and gas treatment, its skills and technologies in exploration-production and its participation to large collaborative efforts at national, European and international levels, with research institutions, industry and public authorities. IFP Energies nouvelles works on:

- the development of innovative and cost-effective processes for capture and transport,
- the validation of technologies for geological storage,
- the elaboration of optimal solutions for the overall chain.

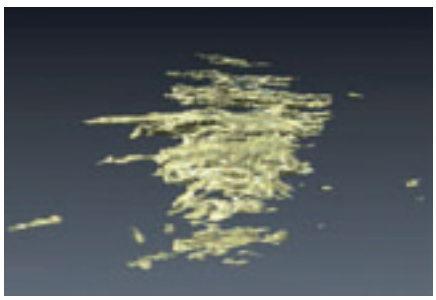
The CO_2 capture industrial pilot unit of the Castor project, coordinated by IFP Energies nouvelles and financed by the European Commission at the Esbjerg power plant (Denmark).



Modeling CO_2 migration in a geological structure using IFP Energies nouvelles' Coores™ software.

Coores software

Simulation of CO_2 underground storage in porous media taking into account the interaction of the CO_2 with rocks and fluids.



Monitoring

4D inversion of seismic data enabling excellent visualization of the flake structure at the Sleipner site (North Sea).

IFP Energies nouvelles is present throughout the CO_2 chain

IFP Energies nouvelles participates in and coordinates numerous projects based on high-level partnerships with industrial playersand other research bodies in France and Europe, as part of R&D framework programs.
The Castor project for example, has been led by IFP Energies nouvelles, together with some 30 partners.

IFP Energies nouvelles is also involved in national and international networks and clubs that direct and drive research in this field.

Bilateral R&D partnerships

IFP Energies nouvelles expertise and experimental facilities are used within collaborative R&D programs for bringing solutions to issues raised by the industrial partner. Such programs are jointly funded by IFP Energies nouvelles and its partner, and are performed on an entirely confidential basis. The results are then jointly owned, and both IFP Energies nouvelles and its partner can benefit from their industrial exploitation.

« For several years now Petrobras has been collaborating with IFP Energies nouvelles on a range of scientific projects and advanced training programs. In the E&P area, research projects cover numerous subjects such as organic geochemistry, basin modeling, etc. Scientific collaborations include bilateral and multiclient projects. Both types of research projects are relevant for Petrobras and IFP Energies nouvelles because new techniques and models developed by IFP Energies nouvelles can be tested in actual geological situations to improve the company's understanding of petroleum systems. »

Henrique L. do B. Penteado, Petrobras

Granting of licences for process, equipment and software

A driving force for innovation, IFP Energies nouvelles has a portfolio of more than 3,000 active patents in the field of exploration-production corresponding to almost 700 inventions.
This means that it can offer industry genuine technology transfers, in which it provides the technical dossier relative to its software, hardware or processes in return for royalties.

Sprex® demonstration unit at Lacq using the process developed jointly by IFP Energies nouvelles, Total and Prosernat.

Joint Industry Projects

IFP Energies nouvelles organizes and coordinates JIPs, collaborative research projects bringing together several industrial partners who jointly fund a program designed to solve a given problem. This formula means that the financial risks can be shared upstream and the research results downstream. This sharing makes it possible to explore avenues that lead to genuine innovations and provides the partners with a real competitive edge by giving them early access to new technologies. IFP Energies nouvelles is coordinating JIPs in partnership with more than 30 international and national oil companies.

« BHP Billiton has been part of the Cougar JIP since it was launched in 2001. The company was quick to realize the potential of using this technology, based on experimental design, in terms of what it could bring to our understanding of uncertainty in complex petroleum reservoirs. With the subsequent launch of commercial software, Cougar™ has become an integral tool for our global asset teams. Today, the JIP is continuing to develop important new concepts and methodologies that will eventually provide new modules for commercial software. »

Alan Curtis, BHP Billiton

The Resources Business Unit

IFP Energies nouvelles' ambition is to develop new methods and technologies in order to push back the current boundaries of oil and gas reserves and provide access to new energy resources. Environmental responsibility is central to this research, particularly in terms of mitigating CO_2 emissions and protecting water resources.

The research programs deal with:
- the capture, transport and geological storage of CO_2;
- software and technologies for oil and gas exploration and production;
- eco-efficient water management;
- activities related to marine and offshore wind energies.

IFP Energies nouvelles - Resources Business Unit
Tel.: +33 1 47 52 60 85 - Fax: +33 1 47 52 70 04
Resources@ifpenergiesnouvelles.fr

IFP Middle East Consulting
Manama centre, part 1, entrance 1 - suite 606-7
P.O box 10813 - Manama Diplomatic Area
State of Bahrain - Bahrain
Tel.: 973 17 21 11 50 - Fax: 973 17 21 11 72
Ifpetrol@batelco.com.bh

IFP Technologies (Canada) Inc.
810, 744 - 4th avenue SW
Calgary, Alberta T2P 3T4
Canada
Tel.: 1 403 234 03 42 - Fax: 1 403 234 85 79
edifptec@telusplanet.net

IFP Energies nouvelles
1 et 4, avenue de Bois-Préau
92852 Rueil-Malmaison Cedex - France
Tel.: +33 1 47 52 60 00 - Fax: +33 1 47 52 70 00

IFP Energies nouvelles-Lyon
Rond-point de l'échangeur de Solaize
BP 3 - 69360 Solaize - France
Tel.: +33 4 78 02 20 20

www.ifpenergiesnouvelles.com

Communications Division - 071008 - Photos: © Franck Dunouau, E. Follet, P. Chevrolat/PhotoFrance, Etsam, IFP Energies nouvelles, X.
Document printed on 100% FSC-certified paper, partially recycled in a printing plant with the *Imprim'Vert* green printing label - Production Graphidoc