UNCONVENTIONAL RESOURCES

EXPERTISE & TECHNOLOGY
Unconventional oil and gas are really no more than conventional natural gas and oil but produced from “unconventional” rocks and strata. For Total, our focus is on extraction from tight rocks (including shale) in which the hydrocarbons are not confined in a traditional trap of a structural or stratigraphic nature. These rocks have such low permeability that they need some form of stimulation to allow hydrocarbons to flow and to be large scale developments to make production economic. Unconventional projects at Total include shale gas and oil, tight gas and oil and coalbed methane. Our objective is to be a major unconventional player through our state-of-the-art expertise, an active R&D program and a sustainable & responsible strategy for developing these resources.
Unconventional resources account for a growing share of global oil and gas production. Their potential can be measured in hundreds of billions of barrels of oil equivalent. Total is now an established industry player — particularly with regard to unconventional gas, which accounts for a large percentage of the world’s natural gas resources. It plays an important part in our strategy to expand our gas portfolio so that it will account for 60% of our production by 2035. Natural gas is one of the best options currently available for combating global warming while ensuring the world has access to the energy it needs. As the fossil fuel with the lowest greenhouse gas emissions, natural gas is a cornerstone of Total’s strategy for helping to tackle climate change.

**NATURAL GAS: SUPPORTING CLIMATE ACTION**

- **Increasing Stimulated Rock Volume (SRV).** Understanding rocks and strata and optimizing the geometry of SRV during fracking operations in zones that can be stimulated are essential for successfully transforming resources into actual reserves and maximizing well productivity.

- **Ensuring financial profitability.** Because of the risks associated with oil price volatility it is important to develop and conduct these projects on an industrial scale with cost effective and fit for purpose techniques. This is beneficial to all participants as we aim to create shared value.

- **Minimizing our impact.** Transparent dialogue and respecting our thorough HSE processes are vital for gaining all stakeholders’ consent to extract these resources. We act in a way that is responsible and acceptable to the community. Water use, landscape impacts, air quality, seismicity: we recognize and understand the environmental concerns about unconventional hydrocarbon production, and we work hard to ensure that all of these are properly addressed.

**SIGNIFICANT CHALLENGES: A WORTHWHILE REWARD**

At Total we already have commercial activities either producing or developing unconventional resources, however we are always working to address the major challenges faced with their development:

- **Minimizing our impact.**

- **Ensuring financial profitability.**

- **Increasing Stimulated Rock Volume (SRV).**
Total was a pioneer of Measurement While Drilling (MWD), which opened the door to commercial-scale horizontal drilling, we are proficient in industrial production techniques for unconventional resources through our extensive experience on flagship projects. We have gained industry-wide recognition for our use of new technology in hydraulic fracturing, as we pioneered the multistage fracturing of horizontal wells in Argentina.

We are industry leaders in the petrophysical and geomechanical characterization of unconventional formations (rock deformation, kerogen maturation, porosity, permeability and fluid flow in nanoporous media). That know-how, combined with our integrated workflow for modeling hydrocarbon extraction and predicting production profiles, enables us to identify areas of greatest potential within a field and pinpoint the optimal fracture positioning throughout the field’s life. This work is in close collaboration with the operations teams.

We employ high-performance in-house solutions:

- **LIPS** (Laser-Induced Pyrolysis System) to analyze total organic carbon (TOC) in promising formations with an accuracy unmatched anywhere else in the world;
- **MRsat®** for oil saturation measurements that are 10 times more precise than those of other techniques currently available;
- **FIB-SEM** (Focused Ion Beam Scanning Electron Microscope) to examine and detail the porosity of source rock on a nanometric scale.
ENHANCED DEVELOPMENT

To minimize costs and execution time, hence improving profitability, we adopt a strict fit-for-purpose approach using guidelines designed specifically for unconventional resources. We have standardized well configurations, enabling “off the shelf” drilling and completion solutions. Our surface installations are minimized by grouping multiple wells from a single production pad. We have also developed modular plants, to provide the option of phased increases in production capacity over time. Because simultaneous fracturing and drilling operations are key to saving valuable time, we use an in-house modeling tool to aggregate and interpret well production profiles. We can determine the optimal phasing and sequencing of a development’s construction.

USING SMART DATA

Improved cost-effectiveness still requires optimal well performance. We have developed an exclusive tool to predict performance levels more accurately. Backed by machine learning algorithms and the power of our Pangea supercomputer, this application can generate thousands of profiles of future locations in less than a minute and identify the best place for drilling a well. When compared to actual production, these predictions have a 90% accuracy, versus just 50% accuracy for type curves. Our researchers are also working on a breakthrough algorithm to determine fluid flow and rock deformation.

At Vaca Muerta in Argentina, we are also using a new technique that is more effective than the “plug-and-perf” method. It continuously stimulates the rock along the horizontal well by means of sliding sleeve tools, without a plug or wireline. This technique significantly reduces the duration and cost of operations while improving SRV connectivity and productivity.

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Strong expertise in integrated project management is a core strength and business mainstay for Total. We have accelerated and consolidated this expertise in the development of unconventional resources thanks to partnerships with several partner companies that play a prominent role in the sector. We are now expanding our presence in this international market by promoting our operating profile.

**VACA MUERTA (ARGENTINA)**

In the Neuquén province of Argentina, the Vaca Muerta formation is one of the world’s largest unconventional discoveries of recent times. We have interests in ten blocks (6 operated) in this giant shale play, with multiple licenses to drill for gas, gas condensate and oil: Aguada Pichana, San Roque and Rincon de la Ceniza. Three pilot projects were launched in 2015, 2016 and 2017 respectively, to test each fluid window (gas, gas-condensate and oil). Following the success, and with a sharp reduction in drilling costs, we launched the first development phase in July 2017 at Aguada Pichana.
BARNETT (USA)

The USA is home to the shale revolution and the development of economically viable production in a developed country. Total has gained invaluable experience through its partnership with Chesapeake Energy in the Utica (oil/gas) and former partnership in the Barnett (dry gas) plays. Today, Total is the operator at Barnett with approximately 2,740 wells, making Barnett the largest unconventional affiliate for Total by well count. Many environmental best practices are applied including: multi-well pads to reduce surface impact, the use of electric drilling rigs to cut down on emissions and routine inspections for leaks and emissions.

SULIGE (CHINA)

Total partners CNPC in a block on the giant Sulige field in north eastern China. In this tight gas field, Total is deploying an array of high-performance factory drilling and hydraulic fracturing technologies to maximize well productivity as well as SRV optimization and cost minimization expertise. The development plan targets the drilling of over 2,000 wells and an anticipated production plateau of 3 billion m³/year. Today more than 500 wells are already on stream. Total has been producing South Sulige tight gas reservoirs in North Eastern China since 2012.

GLADSTONE LNG (AUSTRALIA)

The Gladstone LNG project operated by Santos with Petronas, KOGAS and Total as partners is located in north-east Australia. The project produces coal bed methane from hundreds of wells from four onshore fields covering the Bowen and Surat Basins where the gas is then compressed and delivered through a 420km underground pipeline to an LNG plant on Curtis Island. LNG has been produced from the plant since 2015 with a focus now on further development of the Fairview, Roma, Scotia and Arcadia fields.

“We created this dedicated affiliate in 2016 to take over operatorship from Chesapeake and to keep the expertise that we have here in the US with unconventionals.”

Dave Leopold, CEO, Total E&P Barnett
Total is a major energy player committed to supplying affordable energy to a growing population, addressing climate change and meeting new customer expectations.

Those commitments guide what we do. With operations in more than 130 countries, we are a global integrated energy producer and provider, a leading international oil and gas company, and a major player in low-carbon energies. We explore for, produce, transform, market and distribute energy in a variety of forms, to serve the end customer.

Our 98,000 employees are committed to better energy that is safer, cleaner, more efficient, more innovative and accessible to as many people as possible. As a responsible corporate citizen, we focus on ensuring that our operations worldwide consistently deliver economic, social and environmental benefits.

Our ambition is to become the responsible energy major.