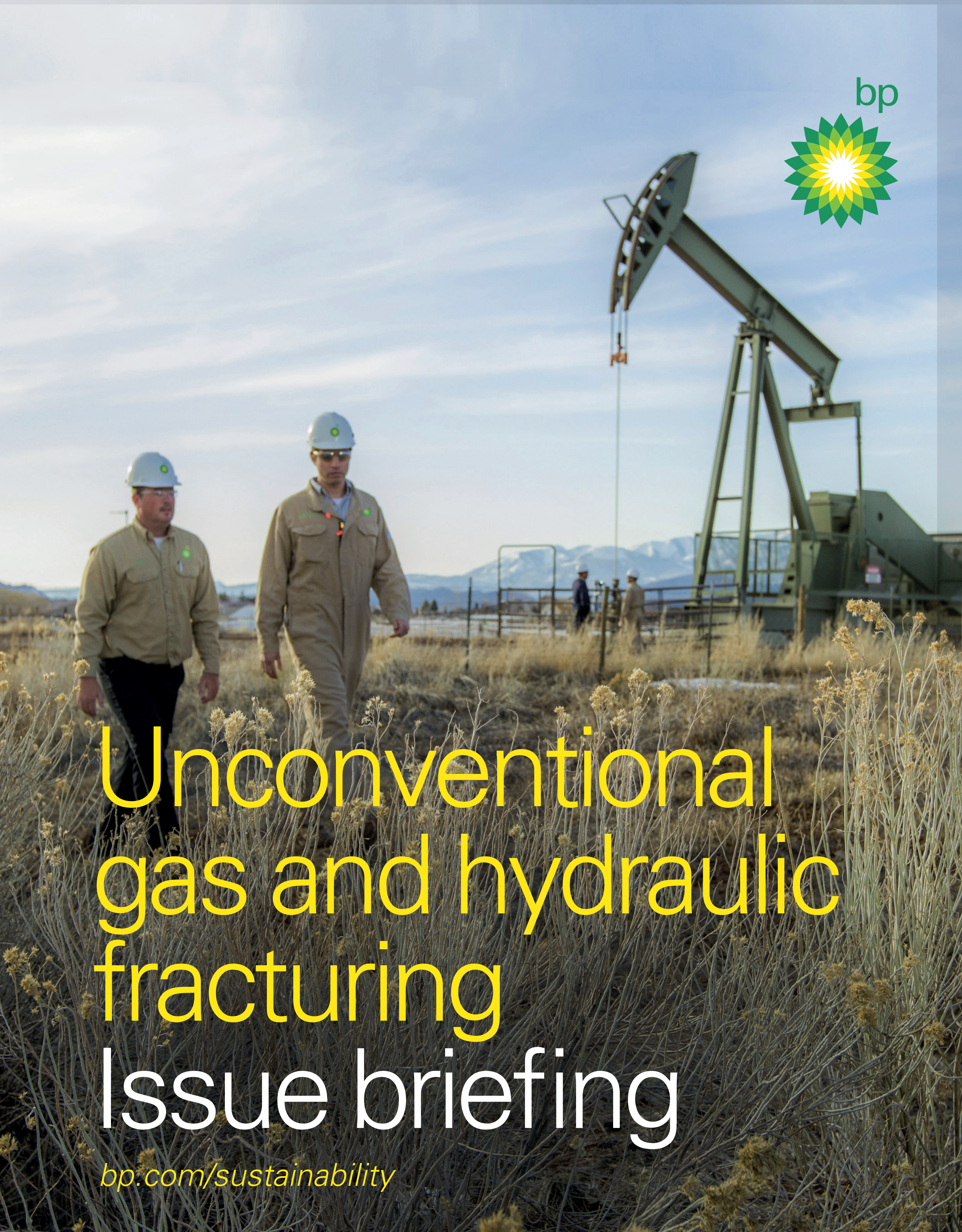

Unconventional gas and hydraulic fracturing

Issue briefing

bp.com/sustainability

How we operate

At BP, we recognize that we need to produce energy responsibly – minimizing impacts to people, communities and the environment.

The energy we produce helps to provide heat, light and mobility in a changing world.

Across BP's operations, established practices support the management of potential environmental and social impacts from the pre-appraisal stage through to the operational stage and beyond – reflecting BP's values, responsibilities and local regulatory requirements.

BP participates in a number of joint venture operations to extract unconventional gas. Some of these are under our direct operational control, while others are not. We seek to work with companies that share our commitment to ethical, safe and sustainable working practices. Our code of conduct states that we will seek to communicate our expectations clearly to our business partners, agreeing contractual obligations where applicable.

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BP and unconventional gas

Natural gas has an increasingly important role in supplying lower carbon fuel to meet the world's growing energy needs.

Natural gas is a vital lower carbon energy source. It produces about half as much greenhouse gas (GHG) emissions as coal when burned to generate power and it can serve as a back-up for intermittent renewable energy sources. In the US, the growing use of shale gas has had a significant impact on carbon dioxide (CO_2) emissions, which have fallen back to 1990s levels.

We expect that natural gas is likely to meet around 25% of total global energy demand by 2035. Shale gas is expected to contribute around a quarter of total gas production by 2035.

We are working to responsibly develop and produce natural gas from unconventional resources including shale gas, tight gas and coalbed methane. We have unconventional gas operations in five states in the US and will be producing gas in Oman from 2017.

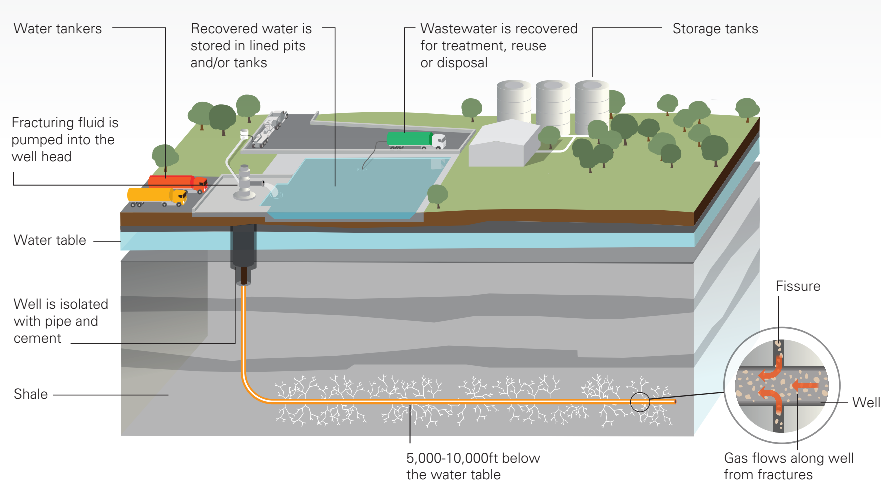
What is unconventional gas?

Conventional natural gas comes from permeable reservoirs, typically composed of sandstone or limestone, where extraction is relatively straightforward because the gas generally flows freely. In contrast, unconventional gas is situated in rocks with extremely low permeability, which makes extracting it much more difficult. New technologies and enhanced applications of existing techniques are making it possible for BP to extract these unconventional natural gas resources safely, responsibly and economically. The combination of horizontal wells and hydraulic fracturing has been key to unlocking unconventional gas reserves in the US and elsewhere.

What is hydraulic fracturing?

Hydraulic fracturing (sometimes referred to as 'fracking') is the process of pumping water, mixed with a small proportion of sand and chemicals, underground at a sufficient pressure to cause the rock to break or fracture. This helps to release natural gas that would otherwise not be accessible. This process has been applied since the late 1940s when Standard Oil of Indiana (later Amoco), now part of BP, developed the technique and performed some of the first fracture treatments in the Hugoton field in Kansas.

Hydraulic fracturing process



Managing methane and other greenhouse gas emissions

We are working to minimize GHG emissions and other air pollutants at our operating sites.

What about greenhouse gas emissions (GHG) and air pollution associated with unconventional gas development?

The sources of emissions during unconventional production are similar to those from conventional production and include flared and vented hydrocarbon gas, fugitive hydrocarbon gas (leaks from equipment), and the normal air emissions from use of natural gas as a fuel.

Air emissions during drilling and hydraulic fracturing operations can result from engines powering the equipment. These emissions occur for the relatively short time required to drill and fracture a well. GHG emissions during these operations are mostly carbon dioxide emissions from fuel combustion.

Once the well has been hydraulically fractured, the liquids pumped into the well must flow back out of the well. This process is known as the completion stage. During this stage, some gas may be flared or vented until there is adequate volume and pressure so that the gas can be separated and sold. At our US sites during the completion stage, we are required through regulation to capture or flare the gas.

Do methane emissions from gas production outweigh the climate benefits of gas over coal and oil?

Minimizing methane emissions from gas production is essential to maximize the role of gas in a lower carbon world.

Methane has a strong warming effect on the climate – trapping substantially more heat than CO_2. But it has a relatively short lifetime in the atmosphere because it breaks down more rapidly once it's released. The global warming potential of methane is at least 84 times greater than CO_2 over a 20-year period. That potential decreases to around 25 times greater when calculated over a 100-year period – the timeframe most governments and companies use to assess its impact.

Methane emissions can occur along the gas supply chain – that includes flaring and venting, to leaks from equipment in gas production through to the delivery of gas to customers. We are working with Imperial College London through the Oil and Gas Climate Initiative to compare GHG and air emissions across different gas and coal supply chains to identify the most effective ways to reduce GHG emissions. Our own life cycle analysis of the liquefied natural gas from our Tangguh plant in Indonesia shows that the GHG emissions from that gas are at least 50% lower than coal.

How does BP aim to minimize emissions at sites?

We aim to minimize air and GHG emissions by using responsible practices and controls at our operating sites. US regulations require us to take the following actions in our Lower 48 operations:

- Apply green completions – this process captures natural gas that would otherwise be flared or vented during the completion and commissioning of wells.
- Control emissions from hydrocarbon liquid storage vessels.
- Conduct leak detection and repair of production equipment – we use a range of techniques, including infrared cameras, to detect gas leaks.
- Implement maintenance programmes to minimize emissions from compressor seals.
- Use lower-sulphur fuels in the engines of our drilling rigs and hydraulic stimulation equipment – this reduces sulphur dioxide emissions.
- Replace pneumatic equipment with lower emissions or no-emissions alternatives. For example, at our San Juan operations, we use solar energy to power equipment and that has led to a reduction in methane emissions and the recovery of gas that would otherwise be vented.

We also reduce transportation emissions by automating some operations – meaning that fewer site visits are required – and by transporting chemicals in dry rather than liquid form, taking up less space on trucks.

And, we reduce methane emissions in other ways, depending on local circumstances. For example, at our Khazzan site in Oman we have built a central processing facility that reduces the need for processing equipment at each individual well site, which can be additional sources of methane emissions in gas production.

We have also incorporated measures to reduce emissions into the design of our Khazzan project, including using the gas we produce to power the central processing facility, which will also provide electricity to power well-site equipment.

How reliable is data on methane emissions?

We are working to build a more reliable and complete picture of methane – one that provides a set of global data categorized by different types of gas fields and operations.

For example, through the Climate and Clean Air Coalition's Oil and Gas Methane Partnership, we are deepening our industry's understanding of the core sources that account for the bulk of methane emissions in upstream operations. This will help to inform actions we can take to reduce emissions.

All this activity builds on the work we have carried out over the past 15 years to estimate methane emissions from our own operations. We calculate that our methane intensity – that is, methane emissions as a percentage of marketed gas production – is around 0.2%.

In 2015 and 2016 we conducted detailed assessments in many of our upstream operations to fine tune our estimates. As this work progresses, we will continue to refine our data on methane emissions and intensity.

Managing water and other fluids

Hydraulic fracturing uses water and other fluids, which need to be sourced, managed and disposed of appropriately.

Can natural gas and drilling fluids enter underground water sources due to the fracturing process?

BP wells and facilities are designed, constructed, operated and decommissioned to prevent natural gas and hydraulic fracturing fluids entering underground aquifers, including drinking water sources. We install multiple layers of steel into the natural gas well and cement these above and below any freshwater aquifers. We test the integrity of our wells before commencing fracturing and again when work at the well reaches completion.

Naturally-occurring methane is often found close to the surface and within drinking water aquifers. We conduct baseline sampling of drinking water wells closest to new drilling locations to measure the presence of naturally-occurring methane in shallow drinking water aquifers.

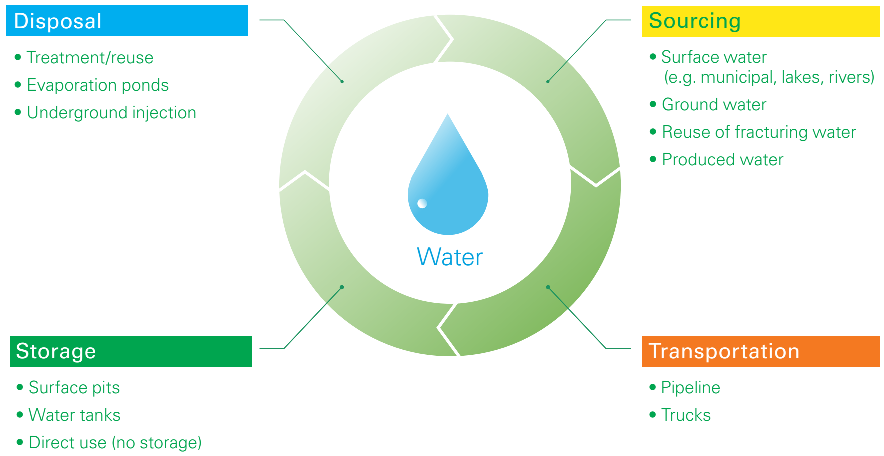
Doesn't fracturing use a lot of water?

A typical shale gas well requires several million cubic metres (m^3) of water for drilling and hydraulic fracturing. The volume of fresh water withdrawn by our unconventional gas operations was 1.3 million m^3 in 2016, which represents 0.5% of the group total. We are testing a number of water-saving innovations, using new technologies that could make it possible for us to treat water used in fracturing for re-use in our operations. We are also looking at ways to reduce freshwater use. One option we are pursuing is treating saline water for use in fracturing activities.

At our Khazzan operation in Oman, we treat wastewater from our sewage treatment plant and reuse it for irrigation, road construction and dust suppression, reducing freshwater demands in an area of water scarcity.

We also support university research and industry developments to identify new water treatment technologies. For example, we have invested in a water treatment company that manufactures desalinization and brine management systems. Development of these technologies will help us to deliver low impact solutions, in terms of water utilization.

Water and unconventional gas development



Are the chemicals used in the fracturing process hazardous?

Water and sand constitute on average 99.5% of the injection material used in hydraulic fracturing. They are mixed with chemicals to create the fracturing material that is pumped underground at sufficient pressure to fracture the rock; sand is then used to prop the fractures open.

The chemicals used in this process help to reduce friction and control bacterial growth in the well. They are mixed in a variety of ways depending on the operational needs of each fracturing operation. Some of the chemicals, when used in certain concentrations, are classified as hazardous by the relevant regulatory authorities. BP works with service providers to minimize their use where possible. We list the chemicals we use in the fracturing process in material safety data sheets at each site.

BP supports transparency regarding the substances used in hydraulic fracturing. In the US, we take part in a number of voluntary disclosure efforts and submit data on chemicals used at our hydraulically fractured wells, to the extent allowed by our suppliers, who own the chemical formulas, at *fracfocus.org* or other state-designated websites. In Oman, our suppliers use similar chemicals, but there is no mechanism for sharing this information with the public.

Where does the water and hydraulic fracturing fluid used in the fracturing process go?

A portion of the fluid used in hydraulic fracturing returns to the surface during production, while the remainder stays underground. The main method of handling water that flows back from the well is to re-inject it into underground formations that are thousands of feet beneath and isolated from drinking water aquifers.

When underground re-injection is not viable, we explore other options including treatment of the water to applicable regulatory standards. In cases where re-injection or treatment is not practicable, we use evaporation ponds to allow the water to naturally evaporate.

Water use across the life cycle

We think it is important to consider water use across the entire life cycle of these resources from production through to converting the resources into energy. Natural gas-fired power plants use significantly less water per unit of energy produced when compared with coal plants. For example, a report by the US Department of Energy found that natural gas-fired combined-cycle gas turbines use about half as much water as coal-fired plants. Massachusetts Institute of Technology also found that the water intensity of shale gas ranks among the lowest of all fuel sources.

Managing our environmental and social impacts

We consider the potential impacts of our operations on the local environment, society and economy.

Does hydraulic fracturing cause earth tremors?

Hydraulic fracturing creates very small earth tremors that are rarely felt at the surface. Before conducting work, BP assesses the potential risk of such induced seismicity resulting from our operations – for example, by identifying natural faults in the local area. This analysis informs our development plans for drilling and hydraulic fracturing activity and we design our operations to mitigate this risk.

Oil and gas production generates large amounts of water which are typically injected back into the ground, either to enhance oil recovery or to dispose of the water. In certain situations, the underground injection of water may pose a risk of induced seismicity. The design, construction and operation of injection disposal wells in the US are highly regulated in the states where we operate. BP also verifies compliance at all third party reinjection facilities before we send our produced water for reinjection. We apply best practices, reviewing and updating our approaches to reflect lessons learned across the industry to minimize the risk of induced seismicity.

There has been an increase in seismic activity in areas near our operations in the US states of Oklahoma and Texas. In recent years, scientists, regulators and industry have come together to implement a number of measures to mitigate the risk of induced seismicity, including resource and data sharing to empower US states to adopt best practices. Many US states have also updated their rules and guidelines for injection well permitting.

In areas prone to induced seismicity, BP assesses the potential risks resulting from wastewater disposal to inform our plans and operations. Experts from academic institutions, industry associations and state and national regulatory agencies continue to study the issue of seismicity, and we monitor these developments for applicability to our operations.

How can unconventional gas extraction affect the local community?

The development of unconventional resources has moved energy companies into new and often more densely populated areas.

Potential impacts include increased traffic, noise, dust, light and air pollution, visual impacts, disruption of wildlife and habitat, and increased pressure on the local infrastructure. These impacts can vary depending on the stage of the operation. For example, the drilling and preparation of wells for production, which includes the process of hydraulic fracturing, typically lasts two to three months. This is when drilling takes place and water and equipment are delivered to the site. The production phase, which may last several decades, has minimal surface impact.

How does BP engage with communities about these impacts?

In the early stages of our projects, we assess the potential impacts of our operations on the local communities and seek to manage them throughout the life of our operations. We are committed to:

- Providing timely and transparent information about our activities to the public.
- Identifying and responding to concerns they raise.
- Offering employment opportunities for local people.
- Training our workforce to maintain positive relationships with local communities.
- Seeking to reduce our impact on the ground through appropriate equipment design and location and management of our work patterns.

A number of our major operating sites are working to improve local and national representation in their workforce. In Oman, for example, BP is working to build local skills through a technician development programme. A total of 85 Omani technicians are currently enrolled in the programme that includes health, safety and environmental technical skills training at a dedicated training centre in Muscat. The programme also includes on-the-job training at other operators' oil and gas sites in Oman, as well as BP sites in the UK and US.

We believe that people living near oil and gas operations, and the general public, should have information about our activities. In the US we support and implement the American Petroleum Institute's recommendations on how companies should engage with the communities where they operate.

One way we engage with our local community is through community advisory panels. For example, we work with the Durango Citizen Advisory Panel, in La Plata County in Colorado, which meets regularly to discuss issues of interest to the local community and BP.

What about the noise from the drilling and the traffic from the trucks?

Drilling and truck traffic can raise concerns over noise and disturbance to the local community. BP seeks to design facilities and plan road, pipeline and well pad locations to limit disturbances and mitigate noise and other impacts from drilling and truck traffic. To reduce the impacts from traffic, we aim to apply dust suppression techniques, install pipelines to transfer water where practical, and minimize the number of kilometres driven. We work with communities to manage traffic movements whenever possible.

Managing our environmental and social impacts (continued)

Is it safe to work at a drilling site?

We have issued guidance throughout BP on how to drill and maintain wells to high, consistent standards. We assess health hazards, such as noise, chemical and silica dust exposure. We also implement hearing and respiratory protection for our workforce where this is needed.

We take road safety very seriously. Drivers are required to undergo assessments and need to be trained, licensed and medically fit to operate a vehicle. We limit the number of hours they can work, and in some circumstances we perform pre-trip risk assessments and develop journey management plans to minimize any exposure to potential hazards.

In Oman we track every journey using a vehicle monitoring system that gauges speed, braking patterns, distances driven, seat belt use and rest periods taken. Drivers are then provided with safety scores and feedback on how to improve.

We conduct spot checks on all contracted vehicles and regularly assess our contractors' safety controls.

We helped pioneer the US National Service, Transmission, Exploration and Production Safety Network, which brings together operators and contractors to promote safety, health and environmental improvement in US onshore oil and gas operations. We are working to apply the lessons learned from this programme in our exploration and production operations globally.

How does BP protect the animals and plants that live close to the operations?

We work to avoid impacts to sensitive habitats and threatened species. If such impacts are unavoidable, we seek to minimize and mitigate them.

We monitor the impact of new gas development and our operations on species. For example, in the San Juan Basin we monitor potential impacts on the population levels and movement patterns of species such as bald eagles and deer. This allows us to better schedule our activities and reduce any impacts.

To minimize land use and reduce the number of well pads, we use techniques such as drilling multiple wells from a single site. We also use construction practices that minimize the physical footprint of the operations, and we carry out field studies in areas such as planting techniques and topsoil storage and reuse to help us restore the land after construction.

BP's corporate reporting suite includes information on our sustainability and financial performance, as well as our global energy and technology projections. We also publish issue briefings on oil sands and unconventional gas development.

Sustainability Report 2016

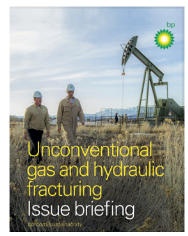
Details of our sustainability performance with additional information online.

bp.com/sustainability

Oil sands issue briefing

Information on our approach to developing energy from Canada's oil sands.

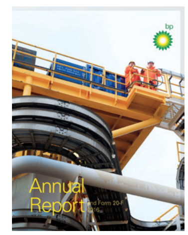
bp.com/oilsands



Unconventional gas issue briefing

Details of our approach to managing the potential impacts of hydraulic fracturing and unconventional gas development.

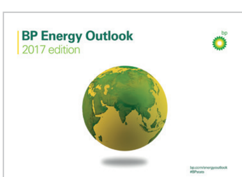
bp.com/unconventionalgas



Annual Report and Form 20-F 2016

Details of our financial and operating performance in print and online.

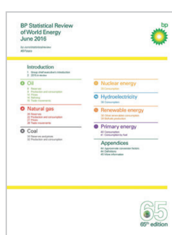
bp.com/annualreport



BP Energy Outlook 2017 edition

Provides our projections of future energy trends and factors that could affect them out to 2035.

bp.com/energyoutlook



Statistical Review of World Energy 2017

An objective review of key global energy trends.

bp.com/statisticalreview

BP Technology Outlook

Shows how technology can play a major role in meeting the energy challenge out to 2050.

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