Saving energy in the oil and gas industry
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Why energy efficiency is important

Oil and gas will remain essential to global economic development and prosperity for decades to come, even with low-carbon policies in place (see Figure 1). However, global concerns about climate change are leading to a focus on the amount of energy it takes to produce these hydrocarbon-based fuels, and the advent of more unconventional sources and methods continue to further increase the energy intensity of production. In the face of these challenges, the industry recognizes that fossil fuel use is a contributor to atmospheric greenhouse gas (GHG) concentrations, and that emissions should be minimized where possible. Energy efficiency and conservation can make a major contribution to both environmental protection and energy security.

Most of the potential for saving energy lies with end users. In addition to producing oil and gas, the industry also uses oil and gas in its own operations, and efficiency can significantly reduce the industry’s impact. As traditional hydrocarbon energy resources are depleted, the production of energy from ever more sensitive and difficult environments is becoming increasingly complex. By focusing efforts on energy efficiency, the industry is striving to ensure that oil and gas will continue to be available, while addressing energy security and environmental concerns in the best, most cost-effective way.

Major challenges remain, notably in countering the increased use of energy to exploit less accessible crude oil resources and to meet tougher fuel quality standards. The oil and gas industry, as responsible producers, aims to provide consumers with a consistent source of energy for mobility and power, to help end-users consume less fuel and to promote rational energy use all along the supply chain.

Energy efficiency and energy conservation are distinctly different; however, both play a role in reducing the amount of energy used. Energy efficiency is about reducing the energy intensity of a process or activity so that less energy is required to provide the same product or service. This can be achieved by introducing more efficient technologies, equipment or processes. On the other hand, whilst definitions of energy conservation differ, it is generally more related to culture, human behaviour and operational procedures. It typically means using less energy by reducing use (e.g. turning off equipment when alternatives are available) or by eliminating unnecessary activities and energy losses, rather than using less energy to accomplish the same thing.

Enhancing energy efficiency is an important issue for oil and gas companies, who can contribute by implementing changes in their operations, planning and investments. There are many positive drivers for industry because energy efficiency can improve productivity, lower operating costs and reduce environmental impacts. Energy efficiency and conservation can also extend the life of finite natural resources and help to keep energy affordable for consumers by lowering investment and operating costs for harnessing new energy resources to meet rising demand.

As an industry association, IPIECA aims to raise awareness of the benefits of energy efficiency and promote the sharing of best practices.
The context

Global energy demand

Global demand for energy is growing, driven by rising population and economic growth. Over the past three decades, world energy use has more than doubled in absolute terms. This increase, in turn, has enabled the world economy to expand, raising living standards and helping to meet the aspirations of millions of people around the world. It is impossible to operate a factory, run a shop, drive a car, or deliver goods to consumers without using some form of energy. As the world’s energy needs grow, the range of energy sources continues to expand to include renewable sources such as geothermal, solar, wind and biomass along with novel energy converters such as fuel cells. However, renewable energy sources (including biomass) currently account for only 13% of supply, and—despite their growth—it will be decades before they comprise a significant percentage of our energy supply.

Even if the global use of renewables doubles or triples over the next 25 years, it is likely that the world would still depend on fossil fuels for more than 60% of its energy needs over that time frame (see Figure 1). For example, the global transportation sector—the fastest area of growth for energy demand—is faced with limited near- to mid-term practical alternatives to petroleum-based fuels. In many cases, oil and natural gas also continue to provide the most readily available and cost-effective source of

Figure 1  World primary energy demand, 1980–2035

Source: IEA World Energy Outlook 2011 (New Policies Scenario, in line with 2°C max temperature rise)
energy to the electric power, industrial, commercial and residential sectors, and they continue to be essential feedstocks for a wide range of industrial and consumer goods. Given this fact that petroleum feedstocks will continue to serve as the world’s primary energy resource for years to come, it is imperative that energy efficiency is a key component of energy management in the oil and gas industry.

Competing goals and challenges

Around the world, there is growing concern about climate change caused by the growth of GHG emissions in the atmosphere. Fossil fuel use is one of the sources of those emissions. Governments and communities are, therefore, taking steps to reduce greenhouse gases. Examples of policy mechanisms to do so include carbon taxes or emissions cap-and-trade schemes, direct regulation of industrial operations to limit emissions, and end-user efficiency standards.

The most effective way to reduce carbon emissions today is to use less energy. Saving energy through improved efficiency and conservation has a central role to play in reconciling the goals of economic development, energy security and environmental protection. A number of recent studies have shown that investment in more efficient energy technologies is often the most cost-effective way of curbing the growth in demand for fossil fuels and reducing emissions of GHGs and air pollutants (IPCC, 2007; IEA, 2006).

While the oil and gas industry makes a vital contribution to meeting the world’s energy needs, the industry’s activities in extracting, processing and marketing fuels also accounts for 27.4% of total global primary energy use (IEA, 2011). Even given the strides in recent years, there remains considerable potential for improving energy efficiency throughout the industry, which can have a significant positive impact globally.
As well as being a major producer of energy, the oil and gas industry is itself a major consumer of energy. That is, large amounts of energy are needed to extract resources from the ground and process, transform, transport and deliver those resources to end users, relative both to the economic value and to the volume of the oil and gas supplied.

Where is energy used?

Oil refining
Oil refining is an energy-intensive activity, accounting for about half of all the energy consumed by the oil and gas industry as a whole. And factors such as more stringent oil product standards (e.g. ultra low-sulphur diesel), increasing demand for lighter products, and heavier crude oil slates all demand increased processing, which in turn places upward pressure on the overall energy intensity for refining. However, steady energy efficiency gains have been achieved in the sector, thanks to the investment in, and focus on, efficiency improvements over the past three decades. Benchmarking indices have become standard in the refining industry as a tool to monitor and drive energy efficiency improvements and compare performance between refineries. As a result, the average energy intensity of the refining industry segment has fallen by 13% since 1980 in OECD countries, according to IEA data.

Oil and gas production
Large amounts of energy are also needed to extract oil and gas from the Earth. Energy use in petroleum extraction covers a range of activities, including: driving pumps to extract hydrocarbons and to reinject water; heating the output stream to allow separation of the oil, gas and water; producing steam and reinjecting gas for enhanced oil recovery; powering compressors and pumps for transporting oil and gas through gathering pipelines to processing plants; and driving turbines to generate the electricity and heat needed for on-site operations.
and living quarters. Energy needs vary widely according to local circumstances and operational conditions. Locally-produced gas is the main fuel used for upstream operations. The energy intensity of oil and gas extraction has been increasing—by approximately one-third since 1980 in OECD countries—despite heavy investments to improve efficiency (IPIECA 2013).

Transportation

Supplying oil and gas products to consumers involves transportation through various modes. Seagoing oil tankers, fuelled by diesel oil and residual fuel oil, as well as pipelines, which mainly use natural gas to fuel pumps and compressors, account for much of the energy consumed in transporting and distributing crude oil, refined products and natural gas. Road tankers and rail cars that distribute petroleum end products to service stations and to various end users also consume significant amounts of diesel. While important advances have been made in improving energy efficiency in oil and gas transport, the resulting energy savings are largely offset by a geographic shift in production to regions that are often further from demand centres, thus increasing the volume of fuel required to deliver the products by pipeline or tanker.

There are two main reasons:

- As oil and gas fields mature, hydrocarbon production declines and water increases as reservoirs become depleted. Yet the amount of work and, therefore, energy required to produce those volumes stays about the same or even increases. Increased use of energy-intensive secondary and enhanced recovery techniques is also boosting energy needs.
- Increasing reliance on less accessible conventional fields such as offshore deep water, heavy crude oil and non-conventional resources such as oil sands, for which the production processes generally require more energy. The energy and environmental costs of recovering these low quality oils have limited their development for decades.
How the oil and gas industry is saving energy

Energy efficiency and greenhouse gas reduction

There is a strong consensus within the oil and gas industry on the importance of saving energy by improving the efficiency of operations along the supply chain and eliminating unnecessary waste. Large investments have already been made, and oil and gas companies continue to devote considerable resources in pursuit of further energy savings. The primary strategies include implementation of energy management systems, developing energy benchmarks, identifying and introducing best management practices, enhancing communication and awareness, driving energy efficiency and GHG emission reduction projects and developing new technologies.

Why energy efficiency?

Energy is needed to extract resources from the ground, and to process, transform and deliver those resources to consumers. Because energy comprises a significant portion of the oil and gas industry’s overall operating costs, companies already have a strong financial incentive to save energy. Using energy efficiently reduces costs along the whole supply chain, improving competitiveness and making end products more affordable for consumers. It is also a powerful environmental tool, reducing the carbon intensity of processes and therefore reducing carbon emissions to the atmosphere. This is why oil and gas companies have invested heavily over the years in more efficient technologies all along the supply chain, and plan to invest more in the future.

But worldwide, opportunities still exist within the industry to make significant contributions towards reducing energy consumption and greenhouse gas emissions by taking advantage of energy efficiency improvements.

Energy efficiency vs. conservation

Energy efficiency and energy conservation are distinctly different; however, both play a role in reducing the amount of energy used. Energy efficiency is about reducing the energy intensity of a process or activity so that less energy is required to provide the same product or service. This can be achieved by introducing more efficient technologies, equipment or processes. On the other hand, whilst definitions of energy conservation differ, it is generally more related to culture, human behaviour and operational procedures. It typically means using less energy by reducing use (e.g. turning off equipment when alternatives are available), or by eliminating unnecessary activities and energy losses, rather than using less energy to accomplish the same thing.
Energy management systems

Many companies have developed and implemented formal energy management systems that seek to incorporate efficiency improvements and emissions reductions into routine business operations. A consistent standard for energy management systems is now available from the International Organization for Standardization (ISO) as ISO 50001, which prescribes the key elements required for effective energy management and efficiency improvements. Elements include a corporate energy policy, a baseline for energy use, improvement goals and action plans, energy reviews and routine evaluation of progress.

Energy management systems have been in place for several years in various segments of the industry. Examples include:

- Exxon Mobil’s Global Energy Management System (GEMS), targeting refinery operations and chemical plants;
- Petrobras’ Energy Efficiency Programme for refining, cogeneration and heating systems; and
- Repsol’s Energy Management Systems in refining and marketing segments including distribution and fuel stations.

Because of the success they bring, energy management systems may become more common throughout the industry in the next 10 years. IPIECA has developed specific guidance on applying the concepts of ISO 50001 specifically for the oil and gas sector, to facilitate the use and effectiveness of energy management systems across the industry (IPIECA 2013b).

Benchmarking tools

Another management tool to facilitate energy efficiency is benchmarking. Consistent metrics can be used to evaluate performance within a facility and also compare energy efficiency between facilities. They can be the basis for setting goals, identifying energy reduction projects and tracking progress.

However, defining relevant energy performance metrics in the oil and gas industry is not a straightforward endeavour. Every refinery and every oil and gas field is unique. In the refining sector, each refinery has its own unique characteristics, shaped by the markets it serves, the local environmental requirements and the types of feedstocks used to make the final product. Each refinery is essentially a collection...
of individual process units, each designed and tuned to produce particular refined products. To address these challenges, the refining sector has developed modular energy performance indexes which take into account the different levels of complexity between refineries.

Oil and gas production is even more challenging and diverse. Fields vary according to whether they are predominantly oil or gas operations, sited onshore or offshore, have markets for natural gas, require enhanced recovery, and a myriad of additional factors. The use of benchmarking tools allows the evaluation of energy efficiency regardless of these diverse conditions.

Best management practices

As oil and gas companies identify successful practices and systems which can be adopted by others in the industry, IPIECA is committed to sharing those best practices. A Task Force is compiling a series of guidelines on ‘Operations Good Practice’ related to:

- power and heat generation;
- efficient use of power for compression, pumping and energy conversion;
- venting of equipment;
- practices specific to wells, process units, and upstream and midstream plants;
- refineries and petrochemical plants; and
- energy efficient design.

IPIECA and its partners have published a number of guidance documents aimed at helping the industry to monitor emissions and develop reduction projects, including:

- Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry;
- Oil and Natural Gas Industry Guidelines for Greenhouse Gas Reduction Projects;
- Increasing the Pace of Technology Innovation and Application: Enabling Climate Change Solutions; and
- Natural Gas as a Climate Change Solution: Breaking Down the Barriers to Methane’s Expanding Role.

Communication and awareness

Industry groups, such as IPIECA, OGP and other partnerships, facilitate the sharing of ideas and promote the awareness of energy efficiency and GHG reduction options both within the industry and externally.

As the oil and gas industry continues to encourage networking and partnerships with other key stakeholders, IPIECA members stand ready to broaden their dialogue with energy consumers on how to save energy for the good of everyone. IPIECA coordinates its activities with a range of stakeholders including:

- United Nations Environment Programme;
- International Association of Oil and Gas Producers (OGP) (www.ogp.org.uk);
Reduction in flaring and venting

One important way in which the oil and gas industry has been conserving energy is by reducing the flaring or venting of natural gas produced in association with crude oil. Flaring is sometimes carried out where barriers to the development of gas markets and gas infrastructure prevent the gas from being used.

The industry is committed to eliminating unnecessary flaring by developing processing and distribution infrastructure in order to monetize the gas.

The Global Gas Flaring Reduction Partnership—a World Bank-led initiative that brings together representatives of governments of oil-producing countries, and state-owned and major international oil companies—facilitates and supports national efforts to use currently flared gas by promoting effective regulatory frameworks and tackling the constraints on gas utilization, particularly in developing countries. The goals of the partnership are to: reduce global methane (and therefore greenhouse gas) emissions; enhance economic growth; strengthen energy security; improve industrial safety; and enhance air quality. These efforts are critical, because methane is the second most important greenhouse gas, accounting for 14% of global GHG emissions and more than one-third of today’s global warming potential.
IPIECA and OGP have developed a guidance document, entitled Preparing effective flare management plans, to further promote reductions in flaring and venting within the industry.

Success stories involving flaring or venting reduction or elimination include Nigeria’s Shell Petroleum Development Company (SPDC)—a joint venture between the Nigerian National Petroleum Company, Shell, Total and Agip. The company invested more than $2.3 billion over a five-year period in building pipelines and compressor stations to gather associated gas and use it in local power plants or for making liquefied natural gas (LNG). As a result, the amount of gas flared has been cut by 30% over that time period (www.shell.com).

Energy improvement projects and new technologies

Investment in a variety of specific energy improvement projects has been ongoing to address the energy efficiency challenge. The oil and gas industry has been a strong supporter of technology development, and has established various partnerships to accelerate the development of carbon capture and sequestration (CCS) and other important technologies (see case studies below). CCS is being sought as a technology to reduce GHG emissions, but is itself quite energy intensive. The challenge is to use CCS as a way to curb greenhouse gas emissions using the best available technology to maximize energy efficiency.

Energy improvement case study: the Athabasca Oil Sands Project (AOSP)

The AOSP, a joint venture of Shell, Chevron Canada and Western Oil Sands, is located in Alberta, Canada, and is the first fully-integrated oil sands project.

Integrated oil-sands projects are very energy intensive, so the AOSP was designed to minimize the energy requirements for financial and environmental reasons. Energy savings were made at the mine by using low-temperature extraction techniques, and through the integration of heat streams and the installation of gas-fired cogeneration facilities.
The Gorgon Project—a joint venture of Chevron, ExxonMobil and Shell—is one of the world’s largest natural gas projects. Carbon dioxide (CO₂) is removed from the gas during processing operations, but instead of disposing of the CO₂ by venting to the atmosphere, the Carbon Dioxide Injection Project plans to inject the CO₂ into the Dupuy Formation which lies around 2.5 km below Barrow Island. This could become the largest CO₂ storage project in the world.

The project represents the application of current best practice in thermal efficiency and greenhouse gas emissions control, recognizing that the gas processing facility will be a large emitter of greenhouse gases.

After injection operations reach full capacity in 2015, the Gorgon Carbon Dioxide Injection Project plans to inject between 3.4 and 4 million tonnes of CO₂ per year. The CO₂ injected will be carefully monitored via a number of surveillance wells and repeated seismic surveying.

The project received global recognition when it was formally recognized by the Carbon Sequestration Leadership Forum (CSLF) at its annual meeting in Warsaw on 8 October 2010.

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**Energy improvement case study: the Total Ecosolutions programme**

The Total Ecosolutions programme is aimed at developing products and services designed to help customers to continuously reduce their environmental impact, such as energy or water consumption. By the end of 2011, it was estimated that the use of Total Ecosolutions products and services avoided 805,000 metric tonnes of carbon dioxide emissions in 2011 (estimate based on sales in 2011). That is the amount emitted by more than 80,000 European Union residents in one year.* ([www.total.com/EN/total-ecosolutions](http://www.total.com/EN/total-ecosolutions))

(*Source: European Environment Agency, October 2010, Greenhouse Gas Emissions Per Capita in EU-27 Member States)

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**New technologies case study: the Gorgon Carbon Dioxide Injection Project, Australia**

The Gorgon Project—a joint venture of Chevron, ExxonMobil and Shell—is one of the world’s largest natural gas projects. Carbon dioxide (CO₂) is removed from the gas during processing operations, but instead of disposing of the CO₂ by venting to the atmosphere, the Carbon Dioxide Injection Project plans to inject the CO₂ into the Dupuy Formation which lies around 2.5 km below Barrow Island. This could become the largest CO₂ storage project in the world.

The project received global recognition when it was formally recognized by the Carbon Sequestration Leadership Forum (CSLF) at its annual meeting in Warsaw on 8 October 2010.
Future challenges: the way forward

The oil and gas industry is facing major challenges in meeting the world’s rising hydrocarbon needs in an environmentally sound and socially acceptable way while curbing its own energy consumption. Many new sources of hydrocarbons, including oil sands, shale gas, gas-to-liquids and biofuels, are inherently more energy-intensive. Tougher standards for refined products and the growing shift towards lighter products are pushing up the energy intensity of refining. The greater distances over which oil and gas must be transported will boost fuel needs, as would the introduction of carbon capture and storage. These challenges make it all the more important to unleash the potential that still exists for the industry to save energy through innovative efficiency gains and conservation. Energy efficiency is often the cheapest, fastest and most environmentally friendly way of meeting the challenges of reducing industry’s own energy needs.

All stakeholders in the hydrocarbon sector—from producers to consumers—have a role to play, working together, to ensure energy is used efficiently and cleanly. The hydrocarbon industry is committed to stepping up efforts to seek out every opportunity for saving energy where it is economic to do so, and to helping policy makers formulate strategies and measures aimed at saving energy and reducing emissions.
References and information sources

Publications


Websites

Alliance to Save Energy: www.ase.org

American Council for an Energy-Efficient Economy: www.aceee.org

International Association of Oil and Gas Producers (OGP): www.ogp.org.uk

International Energy Agency: www.iea.org

IPIECA: www.ipieca.org

World Energy Council: www.worldenergy.org
IPIECA is the global oil and gas industry association for environmental and social issues. It develops, shares and promotes good practices and knowledge to help the industry improve its environmental and social performance, and is the industry’s principal channel of communication with the United Nations.

Through its member led working groups and executive leadership, IPIECA brings together the collective expertise of oil and gas companies and associations. Its unique position within the industry enables its members to respond effectively to key environmental and social issues.

### Members

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IPIECA also has an active global network of oil and gas industry association members. Please refer to our website for a full list.