

Your guide to the
Fife Ethylene plant



ExxonMobil
Taking on the world's toughest energy challenges.™



ExxonMobil is the world's leading publicly traded international oil and gas company. At the forefront of almost every aspect of the energy and petrochemical business, ExxonMobil operates facilities or markets products in most countries of the world, employing around 80,000 people.

In Europe, ExxonMobil is the largest net producer of hydrocarbons, one of the largest refiners of crude oil for fuels and lubricants, and a leading manufacturer of petrochemicals.

In the UK, ExxonMobil has its main offices and operations in Aberdeen, Fawley, Leatherhead, Mossmorran, St Fergus, and offshore in the North Sea. There are over 7,000 employees in the UK, and some 2,000 contractors at any one time. In addition, we provide employment for over 5,000 people indirectly through Esso service stations.

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PHOTOGRAPHY CREDITS

Richard Newton Photography: Shell UK.

ExxonMobil in the UK and Ireland

ExxonMobil's ethylene plant in Fife is one of the largest in Europe. It has been producing ethylene for some 25 years, using feedstock from the North Sea.



Principal interests

- Fuels distribution terminal
- Office
- Gas processing plant
- Chemicals manufacturing plant
- NGL processing plant
- Refinery, chemicals manufacturing plant and marine terminal
- ✈ Airport operations
- LNG terminal
- ⬆ Oil and gas fields
- Underground pipeline
- Gas pipeline

The Fife Ethylene Plant

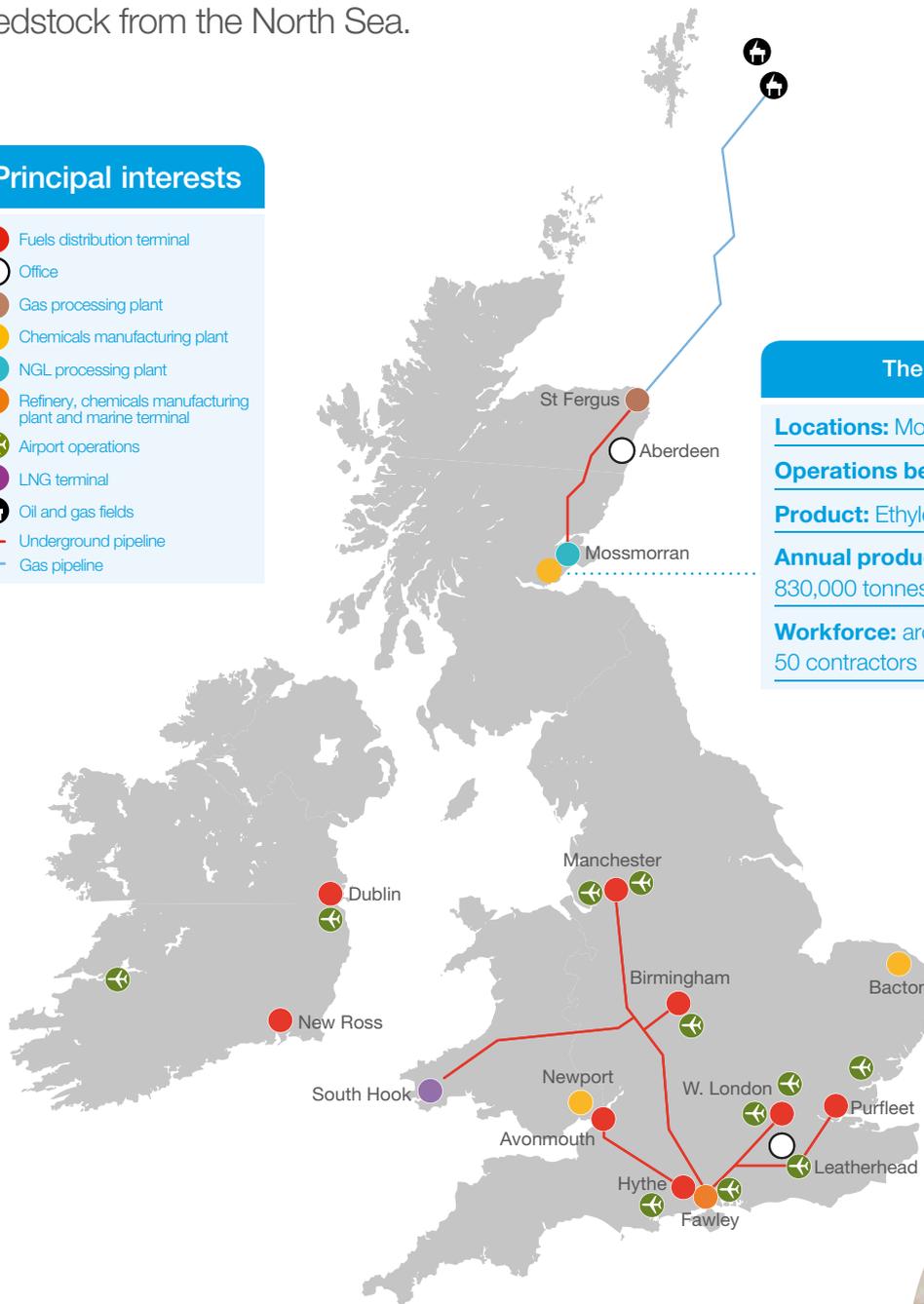
Locations: Mossmorran and Braefoot Bay

Operations began: 1985

Product: Ethylene and C5+

Annual production capacity: 830,000 tonnes

Workforce: around 180 employees and 50 contractors



Welcome to the Fife Ethylene Plant

First opened in 1985, the Fife Ethylene Plant (FEP) is one of Europe's largest and most modern ethylene plants, with around 180 permanent employees and about 50 contractors working there at any one time. Now in its third decade of production, FEP is helping to keep ExxonMobil and the UK at the forefront of the vitally important chemicals industry.



It took **20 million** work hours to build the plant and, at its peak, there were **4,500** people working on the project.

Using natural gas liquids from the North Sea as its raw material, the plant was originally designed to produce 500,000 tonnes of ethylene every year. However, it now has an annual production of some 830,000 tonnes, thanks to improvements made to the plant and its processes. This means that FEP now produces more than 60 per cent extra ethylene each year than it was originally designed to do.

FEP is one plant, split between two locations. The main production site is at Mossmorran, while storage and shipping facilities can be found at the Braefoot Bay marine terminal, four miles away. Around half of the ethylene manufactured at Mossmorran is distributed using the UK ethylene pipeline system, via Grangemouth. The remainder goes to Braefoot Bay, from where it is shipped to Antwerp and elsewhere in Europe.

FEP uses a process called steam cracking to produce ethylene, which involves heating ethane until it breaks down (or "cracks") to form a mixture of ethylene and small amounts of other gases, including hydrogen. This is then distilled further, in a series of processes, to give pure ethylene. Any ethane that doesn't break down is recycled, while by-products of the production process are used as fuel in the furnaces and gas turbine. So the plant is actually self-sufficient in almost all of its energy requirements.

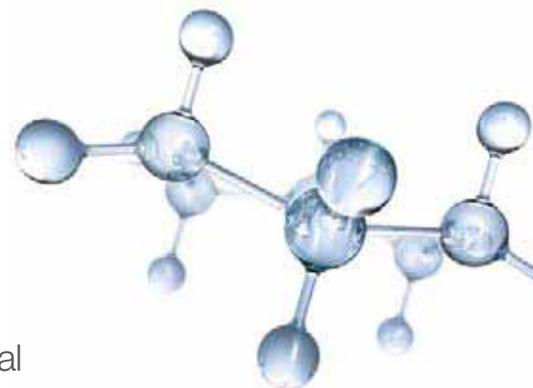
How is ethylene used?

Crude oil and natural gas liquids are most often regarded as "energy" products – substances that fuel cars, homes, factories and offices. However, they are basically mixtures of thousands of different hydrocarbons that can be rearranged to make petrochemical products – one of which is ethylene.

Ethylene is used in the production of a variety of everyday articles that are used around the home, such as plastics, textiles, toiletries, detergents, paints, antifreeze, lightweight car components and medical supplies. It can also be used to help seedlings, vegetables and fruit trees ripen and grow faster.



Safety, health and the environment



The health and safety of employees, contractors and the local community have always been the highest priority for the team at FEP. Protecting the environment is also critical to everyone who works at the plant.

Health and safety

We have an excellent health and safety record at FEP: there has not been a time-losing injury – i.e. one that results in an employee or contractor taking time off work – for over a decade.

The plant is designed to very high safety standards and back-up systems are built in to make sure it can be shut down safely and quickly in an emergency.

All staff and contractors receive thorough health and safety training as part of their everyday jobs, and we work closely with the emergency services to practise the procedures needed in the unlikely event of an incident. Inspectors from the Health and Safety Executive regularly monitor the plant to ensure that it meets all the regulatory requirements.

One of the most visible features of the plant is the flare system. The flare acts as a safety valve, burning off any excess gas to avoid a build-up in the plant.

To enhance our safety, health and environmental performance, ExxonMobil has developed a global Operations Integrity Management System, used across all of our sites. This sets out clearly-defined targets for all aspects of safety, security, health and environmental management. By focusing on these, we can continually evaluate and improve our management systems and standards, while involving every employee in the process.

The aim of our Nobody Gets Hurt programme is to achieve the highest standards for health and safety, and create an environment without accidents, injuries or occupational illnesses.

Following a review by global experts, we have invested **£3 million** to implement **43 new energy-saving** measures.

The environment

FEP is proud of its environmental record, in both waste management and emissions. Water released into the Forth estuary is continuously analysed prior to discharge, and emissions from the plant into the air regularly sampled, to make sure they are within the legal limits. Emissions of carbon dioxide (CO₂) produced by the plant's combustion processes qualify for inclusion in the European Union Emissions Trading Scheme. We record our CO₂ emissions and verification is carried out by an external auditor.

The Scottish Environment Protection Agency (SEPA) and Fife Council's Environmental Health department monitor the plant to ensure targets are met. In addition, staff actively look for new ways to reduce emissions and recycle waste materials as part of our *Protect Tomorrow. Today.* programme.



The production process

The long process of producing pure ethylene begins with natural gas from the North Sea, and ends with the final product being pumped into the UK ethylene grid or shipped from the Braefoot Bay marine terminal.

Brent – the largest oil and gas field in the UK sector of the North Sea – provided the feedstock for FEP right from the start. However, with the decline of Brent production, gas from the Norwegian sector is set to prolong the plant's life, with over 50 per cent of the feedstock coming from the Statfjord and Goja-Vega fields.

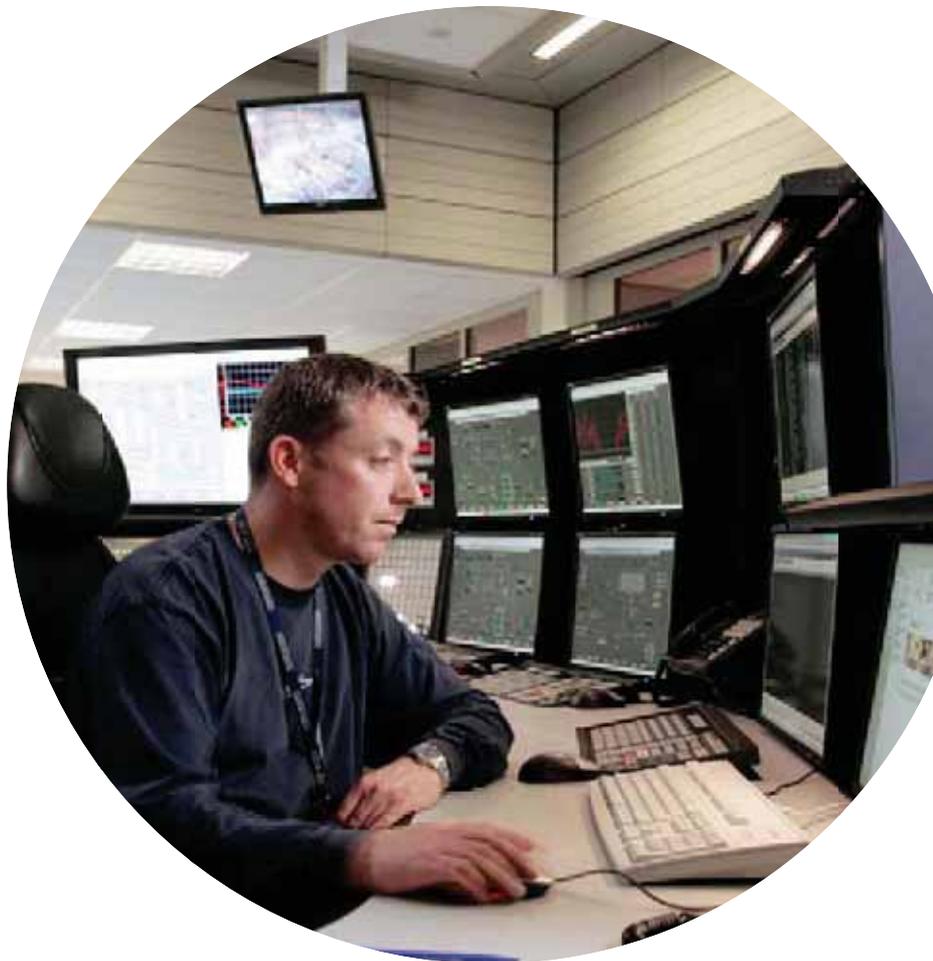
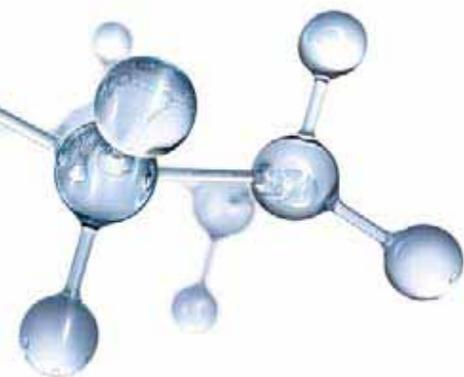
The natural gas is brought ashore at St Fergus, just north of Peterhead, where the methane is removed for distribution as domestic gas for use throughout the UK. The remaining gas liquids are sent to the Fife Natural Gas Liquids plant at Mossmorran, through a 222 kilometre /138 mile underground pipeline. This natural gas mixture is separated and the purified ethane is sent to FEP.

Once at FEP, the ethane undergoes a five-step process to produce pure ethylene:

Step 1: preparation and storage

When the ethane arrives at FEP it still contains carbon dioxide, which must be removed before the feedstock can be used in the production of ethylene. This part of the process – which is known as feed treatment – uses an amine-based solution to wash the ethane and remove the carbon dioxide.

Once treated, the ethane can be processed immediately or temporarily stored in the ethane tank. Propane can be used to supplement the ethane if supplies are low.





Step 2: steam cracking

The next part of the process is the actual cracking, where the ethylene is produced.

The ethane feedstock is fed into seven furnaces, where it is mixed with steam and heated until it reaches temperatures above 800°C. Under these conditions, the ethane breaks down into ethylene and small amounts of other gases, including hydrogen. When the maximum amount of ethylene has been produced, the cracking reaction is stopped by quickly cooling the furnace process stream. Steam generated as the furnace process stream is cooled is used to power machinery at the plant.

Step 3: cooling

The ethylene mix is then cooled to 25°C in a series of heat exchangers and a piece of equipment called a quench tower, where cold water is cascaded down over the gas. During this process some of the by-products, such as tar, condense and are removed. Once it has been through the tower, the water is cooled again, cleaned and returned to the top of the tower to be re-used.

Step 4: compression

Next, the gas is fed into a process compressor, driven by a powerful combination of gas and steam turbines. Once compressed, it is cooled again in what is known as the “cold box”, using a series of heat exchangers.

Step 5: separation

When it reaches very low temperatures, the gas mixture becomes a liquid. The different components making up the gas are then separated by carefully boiling them off in a process known as

distillation (or fractionation). This takes place in a series of three tall towers.

In the first tower, known as the “de-methaniser”, hydrogen and methane are removed from the top. What is left is then fed into the second tower, the “de-ethaniser”. From the bottom of the de-ethaniser, a mixture called C5+ is drawn off. This is a valuable hydrocarbon, which is shipped to Europe for processing in ExxonMobil’s aromatics plant in Rotterdam, and ultimately used to make products like synthetic fibres, packaging and insulation materials.

The ethylene, acetylene and any remaining ethane are removed from the top of the de-ethaniser and they are routed to the acetylene converters where hydrogen is added to convert acetylene to ethylene over a catalyst.

The ethane and ethylene mix then enters the final tower – the “ethylene splitter”. Here the gases separate and any ethane that hasn’t been cracked is recycled back to the furnaces to be processed again.

The final ethylene product is then pumped either into the UK’s 1,000 kilometre ethylene grid or to the marine terminal at Braefoot Bay, where it is stored and shipped to Europe.

The ethane storage tank has a **capacity of 10,000 tonnes** and stores ethane at about minus 100°C.

Powering the plant

FEP uses a range of products and services to support the production of ethylene. Where possible, the plant recycles its by-products to help fuel other parts of the production process.



Water and steam

Water and steam are vital to the production process. Up to 12 million litres of water from the Glendevon Reservoir are used every day to generate steam and help with the cooling process. The water is purified before being turned into steam in the furnaces or used in the three boilers that start up the plant. This steam is used to drive turbines and provide heat in the process.

In doing so, it condenses to form water known as condensate. Because it costs a lot to purify the water from Glendevon, any condensate that can be recovered is re-used.

Rainwater and water used at FEP are eventually pumped into the Firth of Forth. Before any water is discharged, it is cleaned up and collected in a series of ponds where the purity can be ensured. Water is also used to help cool the ethylene process. This water is recycled through a cooling tower so that it can be used many times before it has to be replaced. The water vapour plume from the cooling tower is one of the distinguishing features of FEP. It forms a cloud rising up from the plant, and is often mistaken for smoke.

Fuel gas

The methane and hydrogen mix removed from the top of the de-methaniser tower is recycled and used as fuel gas in the gas turbine and furnaces to create the heat for cracking the ethane.

Electricity

Electricity powers the motors and lighting of the plant equipment and office buildings. In the event of a power failure, the plant is self-sufficient, as it uses its own steam generator until the electricity is restored.

Over **16 million tonnes** of ethylene have been produced at Fife since the plant opened.

FEP in the community

ExxonMobil aims to improve the quality of life for people living close to its operations. We provide financial support for local projects and encourage employees to volunteer in the community.

Working in partnership with specialist third-party organisations, we deliver programmes that support and build our community links. These focus on five key areas: education, the environment, social issues within the local community, health and employee volunteering.

Managers at the plant and members of the local community regularly meet to talk about local issues and identify any ways in which the team at FEP can help. Here are some of the ways in which we've tried to make a positive difference to the local community in Fife.

Education

FEP is committed to supporting young people in the area and runs an Education Trust Programme. The Trust offers apprenticeships in Business Administration, Process Operation and Maintenance. We normally have around 20 trainees at different stages of their apprenticeship working at the plant at any one time.

We are committed to helping people understand the vital role science and technology play in business, as well as the benefits they bring to everyday life. One way in which we do this is through the ExxonMobil Link Schools programme, which we run with our partners Grounds for Learning and the Centre for Research, Education and Training in Energy (CREATE) and Generation Science. The programme provides schools around our principal sites, including our Mossmorran and Braefoot Bay operations, with cash grants for science equipment, science and environmental education expertise and practical support.

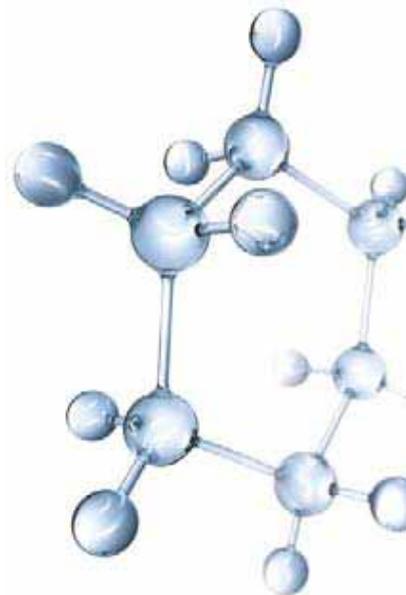
In addition to our Link Schools programme we also support young people through our sponsorship of the Safe Drive Stay Alive campaign, which has already helped over 100,000 young drivers throughout the UK to understand the importance of taking care on the roads.

The ExxonMobil Link Schools programme has **won a top award** from the **UK Energy Institute** for its innovative approach.

Environment

Our commitment to the environment goes far beyond trying to minimise waste and emissions from our sites. We also support local environmental projects, including recycling and energy efficiency programmes. FEP has been a sponsor of Energy Action Scotland for many years, funding projects in local community buildings to improve their energy efficiency and make them more comfortable for people living in the area.

In 2009 the plant was awarded two environmental certifications from the US-based Wildlife Habitat Council for its successful site-based educational environment programmes and for its employee involvement in these programmes. It also won one of the Council's 2009 International Conservation Awards – the first ExxonMobil site to be honoured in this way.





Local neighbourhood needs

Over the last 10 years the Fife Ethylene Plant has supported the local community with over £1.4 million in donations.

This includes charitable donations from the site's Safety Incentive Scheme of approximately £300,000, donations to our local ExxonMobil Link Schools of approximately £450,000 and sponsorships of around £650,000 to local initiatives, such as Project Scotland, Craigencait Ecology Centre and Safe Drive Stay Alive.

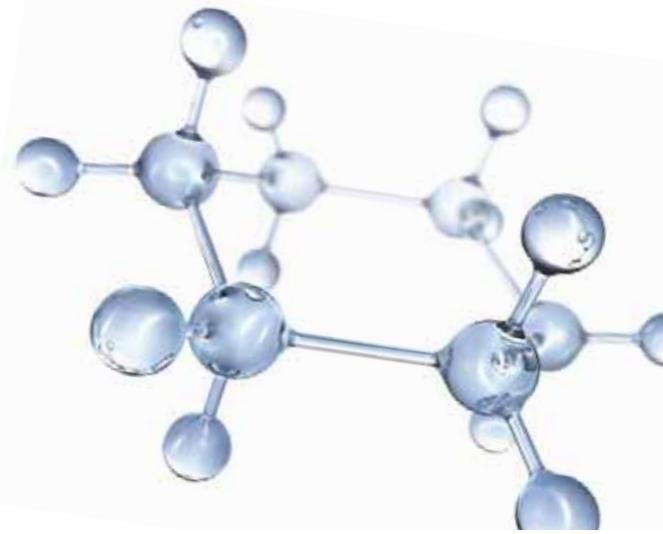
Health

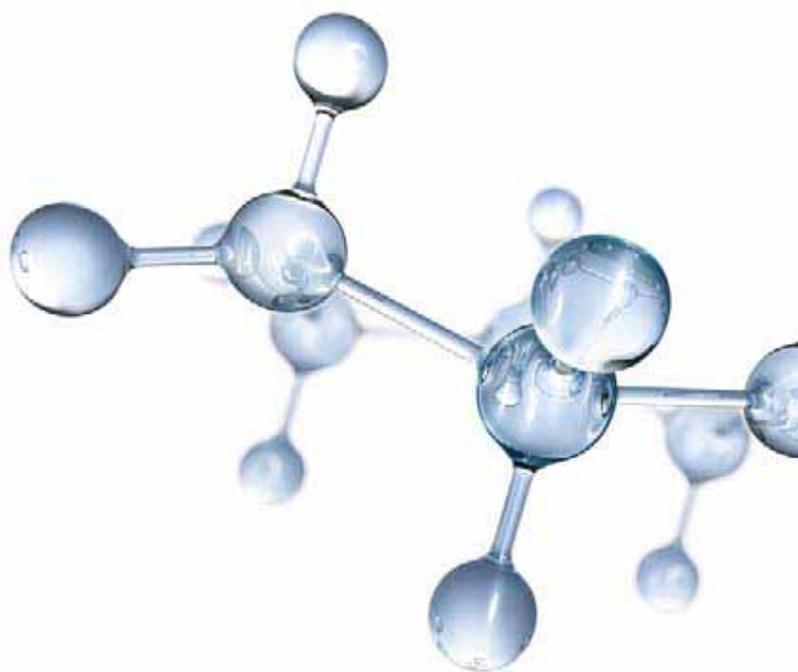
We have sponsored a number of local health-related projects, including providing pashminas to the Maternity Unit at Forth Park Hospital in Kirkcaldy to enable new mothers to get closer to their babies. In addition, we have equipped four local ambulances with "shock boxes" which could save the lives of people suffering heart attacks. A donation to Victoria Hospital has helped to brighten up the children's ward with new furnishings and equipment.

Employee volunteering

We actively encourage employees and their families to contribute their time, talent and energy to charities and not-for-profit organisations, including schools. Those who volunteer can apply for grants for the organisations they support. Amongst many other projects, employees at FEP have given up hours of their own time to help the Fife Ranger Service and redevelop the Dalbeath Marsh nature reserve, near Cowdenbeath.

Each year, hundreds of ExxonMobil employees volunteer to help a local community project, as part of our annual **Day of Caring** programme.





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