

# Oil refining

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GCSE key words  
Fractional  
distillation  
Crude oil  
Fossil fuels

Oil supplies from the North Sea and the Middle East are often in the news. This article describes how oil is extracted and refined in another part of the world. Apart from some straightforward science it also looks at human impact on the environment, an important topic in your GCSE science course.

The most important commercial energy sources in the Caribbean are oil and natural gas, found mostly around Trinidad and Tobago. Oil and natural gas are fossil fuels, formed from organic matter deposited in sediments beneath the sea millions of years ago. As the layers of sediment built up, heat and pressure transformed the organic matter in the rocks into oil and gas. Most of the oil in Trinidad is found in rocks which were laid down about 10 million years ago.

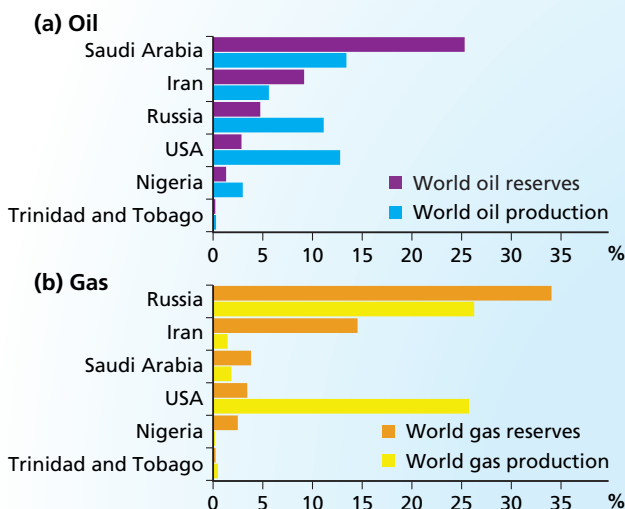
An oil field is an area where oil is held in the pore spaces and joints of some layers of permeable rock. Oil is less dense than rock so under the right conditions it may seep to the surface.

## OIL IN TRINIDAD AND TOBAGO

The Pitch Lake in southern Trinidad is a large mass of oil and other substances which has found its way to the surface. In fact, Trinidad was one of the world's first producers of oil:

- bitumen from the Pitch Lake was used to tar ships as early as the sixteenth century;
- the first oil well was sunk in 1857;

Figure 1 World oil (a) and gas (b) reserves.



- commercial oil production started in 1908;
- the first refinery was opened in 1912.

Drilling a well is an expensive business (see Figure 2). Most oil wells in Trinidad are over 1100 m deep and the deepest are between 5000 m and 6000 m. Drilling a well on land costs around US\$2 million. At sea it may cost four times as much. On average, only 10% of wells find commercial quantities of oil.

Trinidad and Tobago is the only Caribbean country which is a net exporter of oil. The industry in Trinidad is small by international standards because Trinidad has only 0.05% of the world's proven oil reserves (Figure 1). Oil production peaked in 1978. It has declined since then, because reserves are running out.

Much of the oil in Trinidad's reserves is difficult and costly to extract. This is because:

- the rocks are strongly folded and faulted, with many small oil traps, each needing a well;
- in many oil fields there is no longer enough oil to flow naturally to the surface so it has to be forced out by injecting water, steam, or gas into the oil-bearing strata;
- over 75% of the oil is now extracted from marine oil fields, where drilling and extraction costs are much higher. The most productive oil and gas fields are off the east coast, in rocks beneath the sea which is 60–180 m deep. As these run dry, there are plans to drill in water up to 1500 m deep.

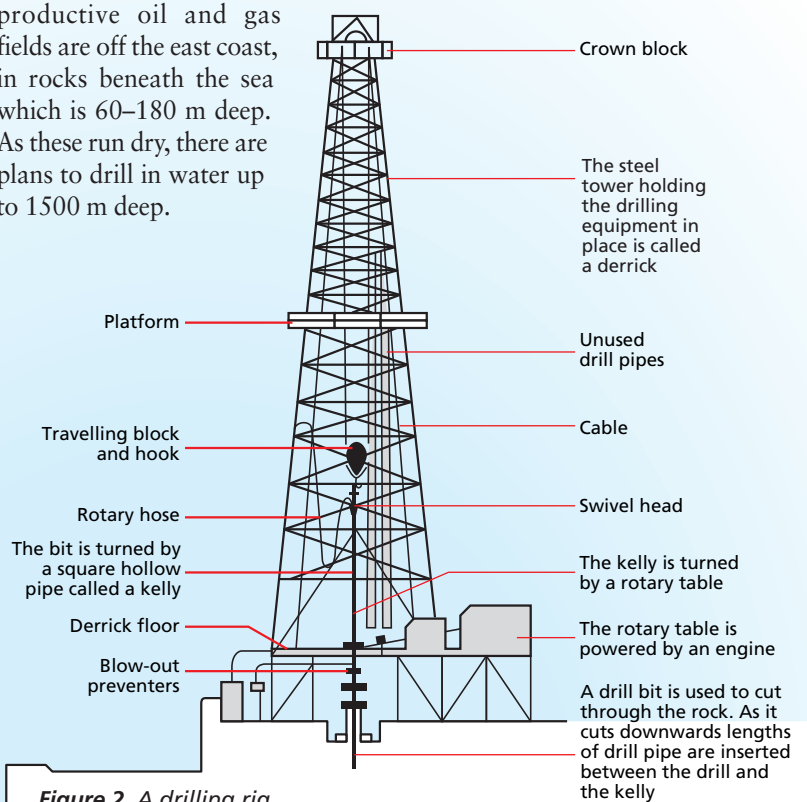
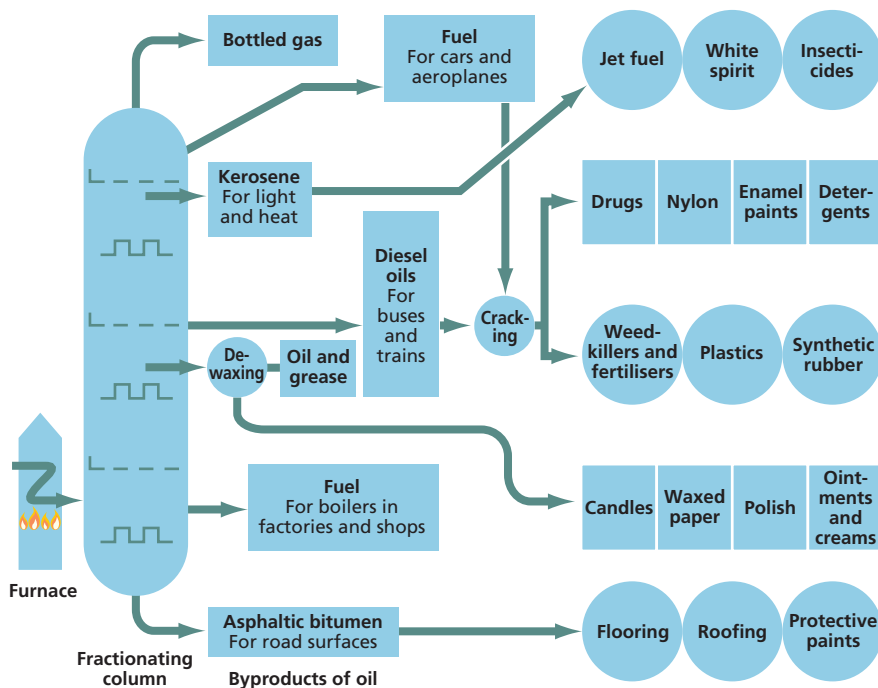
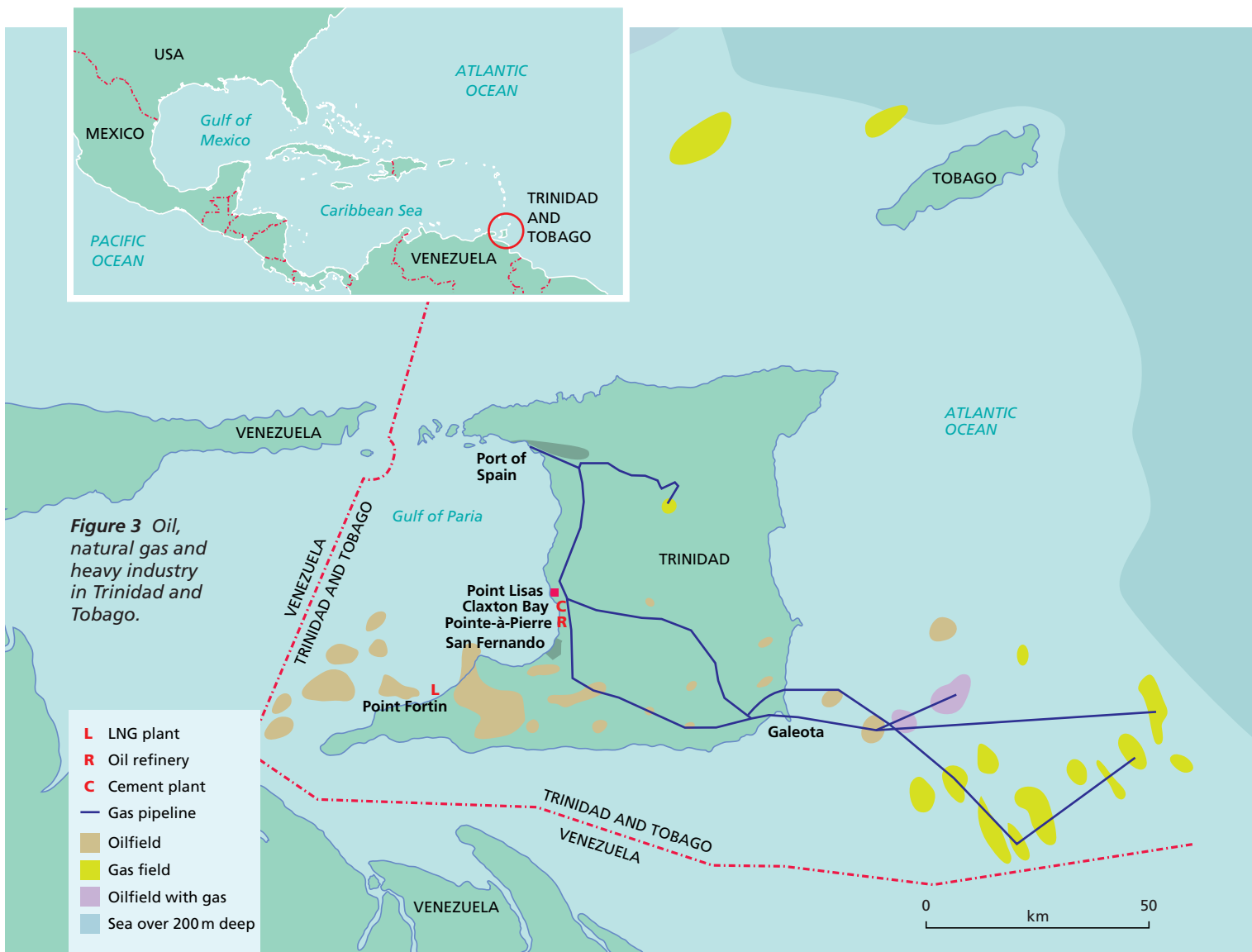


Figure 2 A drilling rig.

When a marine oil well has been drilled a production platform is used to extract oil or gas.

Go to <http://www.hydrocarbons-technology.com> Click on **industry projects** to find out more about the refinery mentioned in this article. Find out about planned developments in Alaska, where concern has been expressed about impacts on the environment.



**Figure 4** How oil is refined

## OIL REFINING

Trinidad's only oil refinery is at Pointe-à-Pierre in the south of the island (see Figure 3). Although the refinery was modernised between 1991 and 1996, it is not as efficient as some of its international competitors. Oil refining is described in Box 1 and Figure 4.

Half the crude oil extracted in Trinidad is refined locally, together with some imported from South America, but crude oil from the east coast fields is refined overseas.

## CRACKING

Oil refineries do not only produce fuels. Chemicals produced by fractional distillation may then be broken down (or 'cracked'), using catalysts and high temperatures and pressures to produce other hydrocarbons. These liquids and gases are used by the chemical industry to make products such as fertilisers, plastics, dyes, solvents, resins, paints, adhesives, medicines and

## BOX 1 OIL REFINING

Crude oil is a black, tarry substance, made of a mixture of different hydrocarbons. In a refinery, the different constituents or fractions of crude oil are separated by fractional distillation.

- ❖ Crude oil is heated to 300°C in a furnace. The furnace is usually fuelled by natural gas.
- ❖ In the furnace, all the fractions in the crude oil evaporate, and become gases.
- ❖ The gases are fed into a 40 m high metal tower called a fractionating column.
- ❖ The fractionating column contains horizontal trays. The trays have holes with bubble caps which allow vapours to pass through.
- ❖ The gases cool down. The heavy fractions become liquid again at quite a high temperature. The liquids condense out and separate from the other gases at the bottom of the column.
- ❖ Lighter fractions travel to the top of the column, and condense there.
- ❖ Gasoline and aviation fuel are much more valuable than the heavier fractions. A modern refinery contains equipment which splits the large molecules which make up the less valuable fractions. This equipment allows the refinery to produce additional gasoline. Sulphur is also extracted. High-sulphur fuel produces sulphur dioxide and other pollutants when it is burnt. Only low-sulphur fuel can be exported to the main international markets. Sulphur which is extracted by a refinery can be sold for use by the chemical industry.

textiles. A petrochemical plant at Pointe-à-Pierre produces MTBE (methyl tertiary butyl ether), a liquid which is added to gasoline to reduce pollution.

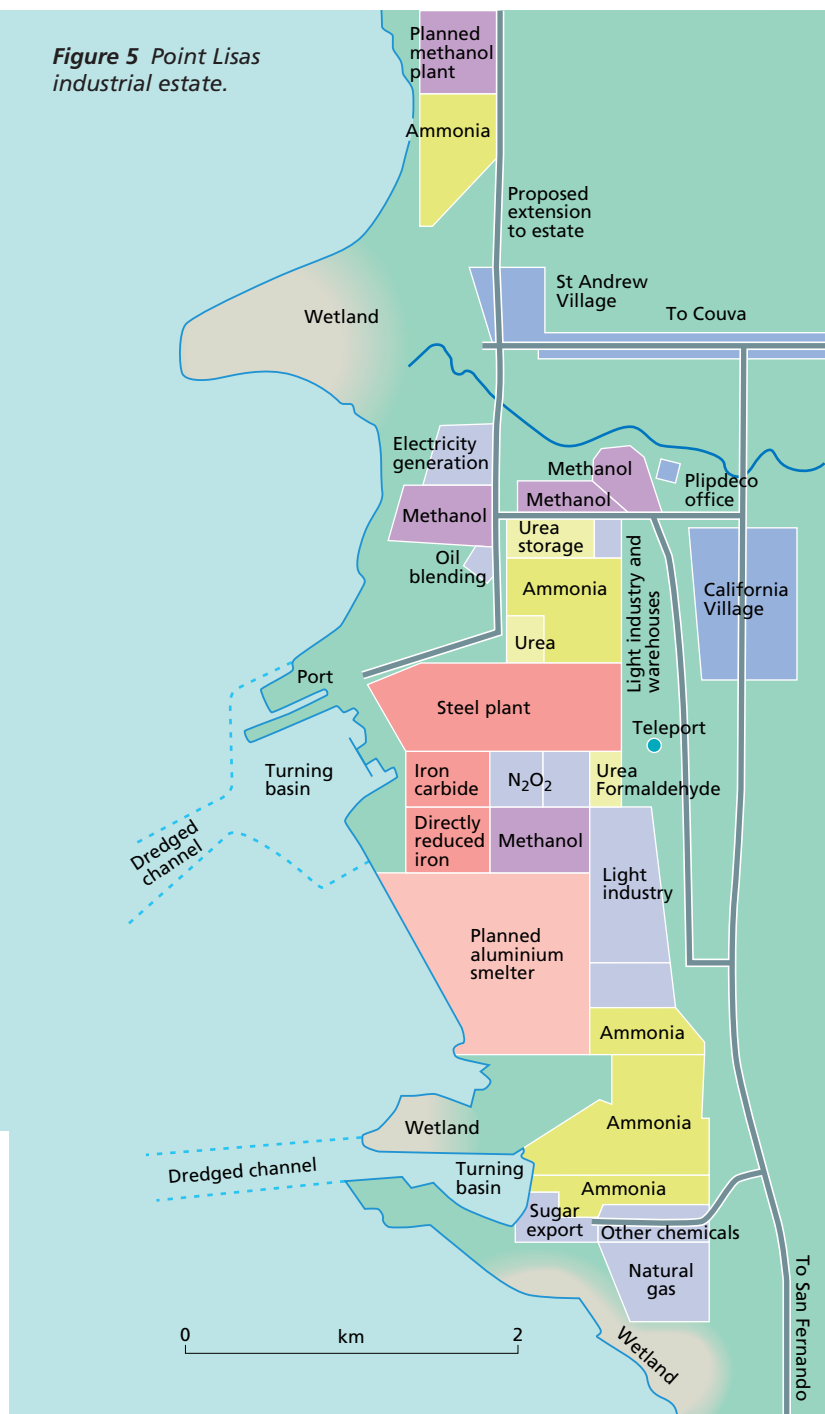
## HEAVY INDUSTRY LOCATION

Trinidad and Tobago has the main concentration of heavy industry in the Commonwealth Caribbean (Caricom). Heavy industries do not always have to be close to their raw materials, but they need large amounts of energy, and good transport facilities. Water transport is much cheaper than land transport for large quantities of heavy goods.

The main centre of industry is Point Lisas industrial estate (Figure 5) which has:

- a port, with a deep-water dredged channel and turning basin for large bulk carriers;
- a very large electricity-generating station;
- a plant which extracts liquid fuels such as propane and butane from natural gas;
- plants producing methanol which is added to petroleum to reduce pollution and used by the chemical industry.

Figure 5 Point Lisas industrial estate.



Trinidad is one of the world's leading exporters of methanol and ammonia. Petrochemicals are exported by tanker to North and South America and Europe.

Heavy industries like those at Point Lisas:

- have a high output;
  - produce goods which can be exported;
- but also:
- are expensive to set up;
  - use a large area of land;
  - do not provide many jobs.

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● Look at Figure 5 and identify chemical industry plants at Port Lisas other than those mentioned in the text. How is aluminium smelted? Find out what iron carbide and ammonia are used for.