RYE HOUSE POWER STATION

Rye House, a 715 megawatt (MW) combined cycle gas turbine (CCGT) power station, was acquired by ScottishPower in early 2001. The station, located near the market town of Hoddesdon, Hertfordshire, about 18 miles north of London, was built in the early 1990s and was fully commissioned in November 1993. Output from the station is enough to meet the daily power needs of nearly a million people – almost the population of Hertfordshire.

The main items of plant are three gas turbines, three heat recovery boilers, a steam turbine and an air-cooled condenser, the largest structure on the seven hectare site. The area around Rye House Power Station has an interesting history. Nearby stands the ruins of the original Rye House, a Jacobean mansion, which achieved notoriety for the "Rye House Plot" – a conspiracy to kill Charles II. Today only the gatehouse and foundations remain.

The Rye House site, bounded by the River Lee and the main London to Cambridge railway line, has been used for power generation since 1953 when a coal-fired station was commissioned, designed by Sir Giles Gilbert Scott (whose other work includes Battersea Power Station and Liverpool Cathedral).

An open cycle gas-oil station, which used modified aero engines was built in 1966. Both former stations were closed in 1984.

One of the main north to south 400 kilovolt (kV) electricity transmission lines crosses the site. This and the proximity to the gas National Transmission System made the site particularly suitable for a CCGT power station.

Rye House operates as part of ScottishPower's UK Generation business, playing a valuable role in the electricity markets in England and Wales.

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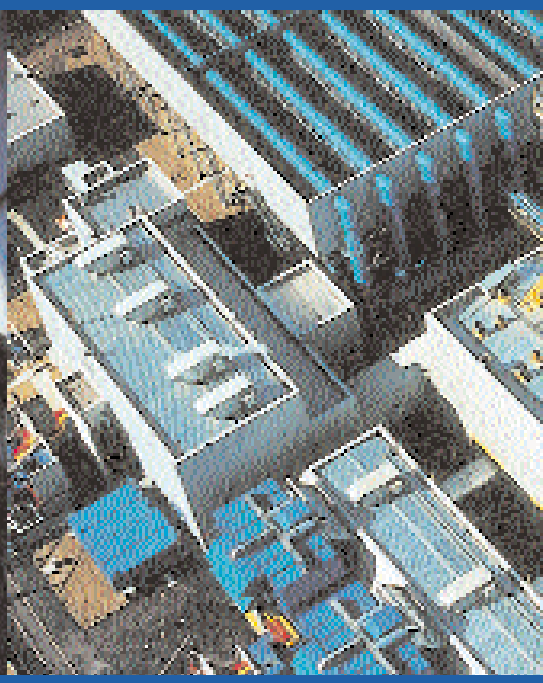
Meeting the energy needs of a million



HOW THE PLANT WORKS

Rye House is a combined cycle gas turbine (CCGT) power station which uses a gas turbine along with a steam turbine generator, to provide the most efficient form of thermal electricity generation.

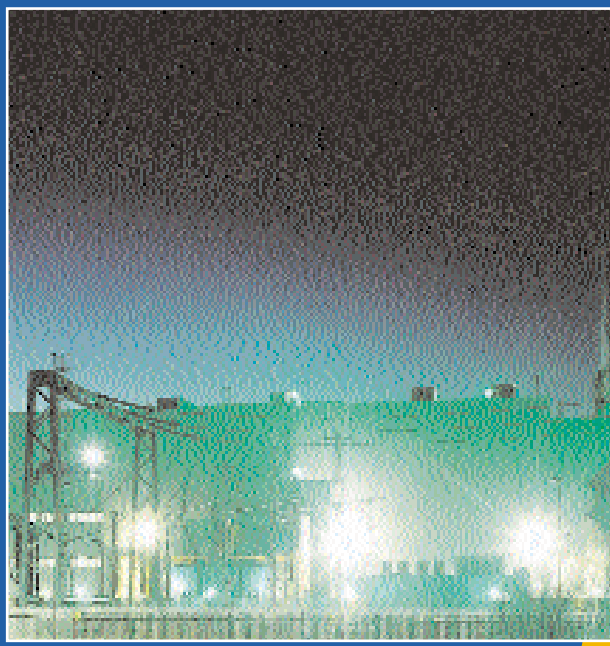
The station burns gas which is delivered via the National Gas Transmission System, with a specially-built 20 kilometre pipeline providing the link with the station.

At full output, Rye House burns 39 cubic metres of gas per second – more than the total domestic usage of Wales.

A gas turbine works in a similar way to a car engine: air is compressed and heat is added by burning fuel. The hot air then expands, through blades, which forces a shaft to rotate and drive a generator, producing electricity.

Usually hot exhaust gases from the turbine are lost to the atmosphere, resulting in wasted heat energy. At Rye House, however, they are fed into a boiler to produce high pressure steam which is used to drive another generator, creating more electricity.

There are three Siemens single-shaft V94.2 gas turbines at Rye House, each capable of generating 150 MW of power. The turbines can compress half a tonne of air per second to a pressure of 11 bar, which raises the temperature of the air to 330° C. Natural gas is then burned in this compressed air, which raises the temperature in the two multi-burner chambers to between 1,100° C and 1,450° C. The combustion gases are then directed through a turbine where heat energy rotates the turbine shaft at 3,000 revolutions per minute, driving the generator. The power is fed into a generator transformer which steps up the voltage from 11,000 volts to 400,000 volts. It is then sent to the National Grid substation across the site, where it enters the electricity transmission system.



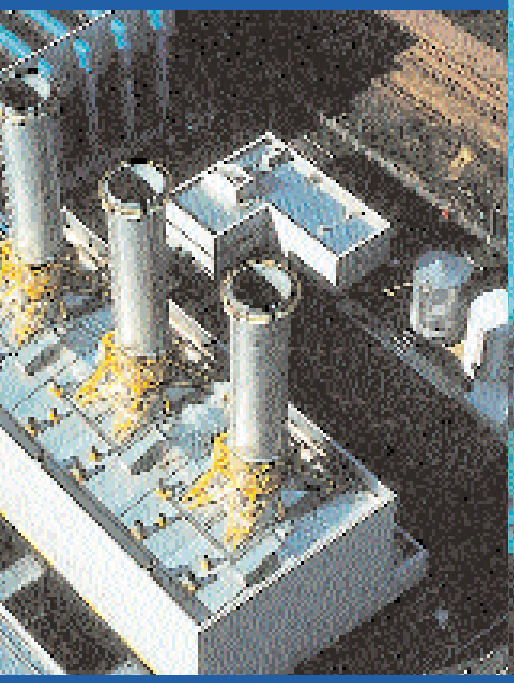
HEAT RECOVERY

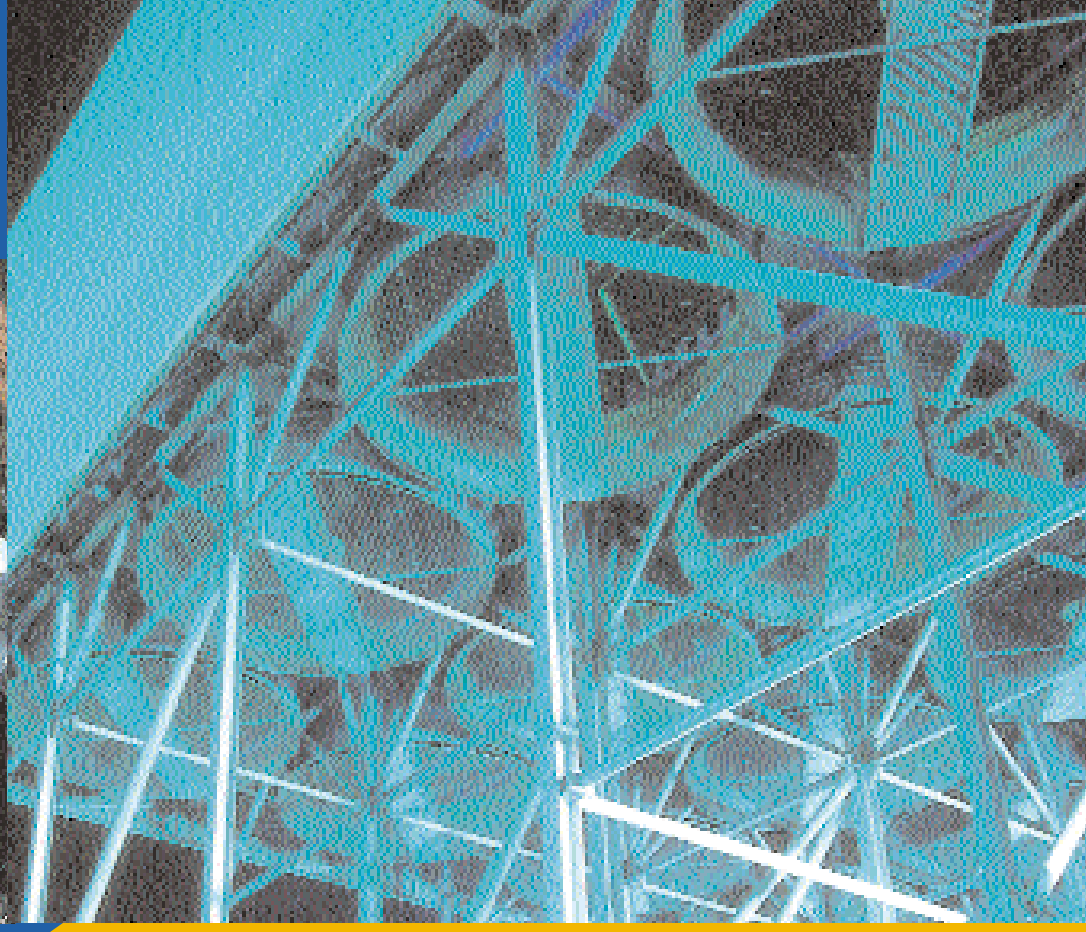
Exhaust gases from the turbines, at a temperature of 540° C, are fed into the heat recovery boilers. The three heat recovery boilers, one for each of the turbines, uses heat from the exhaust gases to make steam. Each boiler contains over 120 km of tubing, which is filled with purified town's water. The water in the tubing is heated by the hot exhaust gases and steam is produced, at two different pressures, in order to maximise heat recovery. The waste gases from this part of the process are then released through the chimneys.

THE STEAM TURBINE

The steam created in the heat recovery boilers is used to drive a steam turbine, which drives a 250 MW generator. The high

people





pressure superheated steam, at a temperature of 530° C passes through the turbine, expanding so that its heat energy drives the turbine rotor at 3,000 rpm.

The steam leaves the high pressure turbine at 194° C and a pressure of just over six bar. It is then mixed with steam from the low pressure side of the heat recovery boilers before entering the low pressure turbine. After passing through the low pressure turbine (under a 90% vacuum, which extracts the maximum available energy from the lower temperature steam) the wet steam remaining passes into an air cooled condenser where it is turned back into water, pumped back into the boilers and used again.

AIR COOLED CONDENSER

Rye House has the largest air-cooled condenser in Europe. Most power stations use water cooled condensers which, for inland sites, require vast quantities of cooling water from rivers.

Such a system at Rye House would need 60,000 gallons an hour to make up losses from evaporation. The air cooled condenser at Rye House covers an area of around 8,300 m^2 – the size of one and a half football pitches. It works by releasing heat through 600 radiators units mounted 24 metres above the ground. These are made up of 60,000 lengths of oval finned tube which, if extended end to end would stretch over 160 km. Cooling is enhanced by the use of 100 fans with a blade diameter of 6.1 metres. These rotate at 68 rpm.

CONTROL & INSTRUMENTATION

Rye House incorporates a high level of automation, the nerve centre for which is the central control room. Here, a bank of visual display units provide operators with real time information on all aspects of the generation process.

Sophisticated control systems can automatically start up or shut down the generating units, according to scheduling instructions from ScottishPower's UK Trading team in Glasgow. Although these processes are carried out automatically, experienced operators can over-ride these systems whenever it is necessary to do so.

Rye House can reach full output from cold in around two hours – or less than an hour if the plant is still warm.

ELECTRICAL

Electricity is generated by the gas turbines at Rye House at 11 kilovolts (kV) and at 15.75 kV by the steam turbine. These outputs are stepped up to the grid voltage to 400 kV by generator transformers on site. The power then travels via underground cable to a 400 kV substation, half a kilometre away, where it can be switched to the relevant circuit to be transmitted to where it is needed.

RYE HOUSE FACTS

■ Approximately 96% of all the water used in the production of electricity at Rye House is recycled to be used again

■ Rye House has three chimneys which each are 58 metres high

■ Each boiler contains more than 120 km of tubing

■ The blade tip on the last row of blades in the steam turbine rotor travels at around 1,350 mph – nearly twice the speed of sound

■ The air coooled condenser, which works on the same principle as a car radiator, saves the use of one million gallons of river water per day

■ One gas turbine produces the same power as 3,000 cars.

ENVIRONMENT

One of the great advantages of combined cycle power plants is their efficiency at converting fuel into electrical energy – over 50% – which means less fuel consumption and lower levels of emissions per unit of electricity generated, compared with less efficient thermal plant.

Natural gas does not give rise to emissions of dust, ash or sulphur dioxide (SO_2) which has been linked with "acid rain" damage to ecosystems and respiratory irritation in humans, while Low NO_x Burners reduce the formation during combustion of other acid rain gases, oxides of nitrogen (NO_x).

Specially designed combustion chambers, incorporating hot ceramic tile liners, helps to ensure that all the carbon in the fuel is converted into CO_2 rather than carbon monoxide.

CCGT stations like Rye House produce roughly half the emissions of CO_2 – a "greenhouse" gas which has been linked to global climate change – of a coal-fired plant.

The station receives water from Thames Water via a dedicated water main which is purified for use in the steam turbine. The use of an innovative air-cooled condenser ensures that very little water is used in the cooling process.

All process water used is treated on site before being discharged into the local sewerage system. Only surface drainage water goes into the River Lea, adjacent to the station, as the river provides a source of drinking water for the city of London.

The Rye House site, in a prominent part of the Lea Valley close to a regional park, was integrated into its surroundings with extensive landscaping, including the creation of a 3.6 hectare ecological conservation area – a vast improvement on what used to be the coal plant of the previous power station.

Wild orchids, which flourish on the site, have been transplanted. An existing pond has been retained and two new ponds have been established to encourage wetland flora and fauna. Wildlife seen in the area include Kingfisher, left, and Foxes, below.

Around 5,000 trees, including indigenous species such as Oak, Willow and Poplar, and 9,000 shrubs were planted as part of the landscaping measures undertaken during the construction of Rye House, enhancing habitats for insects, birds and small mammals.