



POWER FOR TODAY



**AUSTRALIAN ATOMIC
ENERGY COMMISSION**

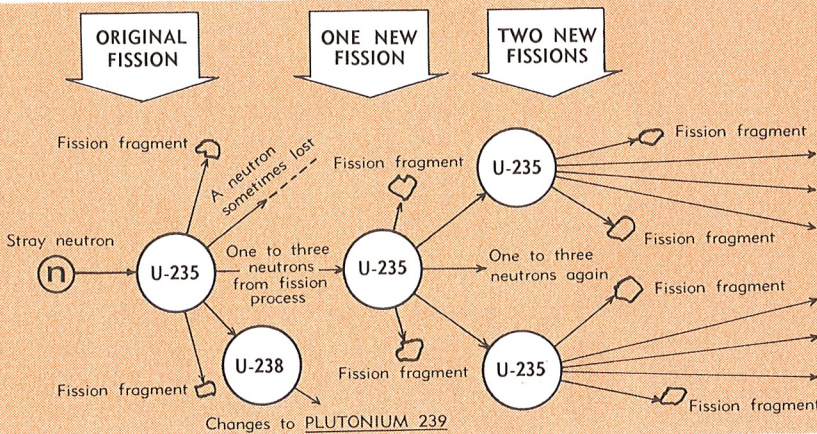
Produced by the AAEC Information Services Section,
45 Beach Street, Coogee, N.S.W. 2034.

NUCLEAR POWER ARRIVES

In 1965-66, electricity generated by nuclear means became cheaper in several parts of the world than electricity generated from coal.

By 1975, there will be 293 nuclear power reactors, with a total capacity of 138,000 megawatts, in operation in 27 countries.

This will be the climax of a long period of research and development since Enrico Fermi, in 1942, built a nuclear pile in which the first controlled nuclear chain reaction took place.



This diagram shows what happens in a chain reaction resulting from fission of uranium 235 atoms.

HOW A REACTOR WORKS

When a uranium atom splits, it emits two or three neutrons; these strike other uranium atoms, causing them to split in turn. The neutrons emitted when an atom splits are travelling too fast to be effective in causing further fissions and must be slowed down to an appropriate speed. This is done by a substance called a "moderator"—usually water or graphite. The neutrons collide with atoms of the moderator, and lose speed.

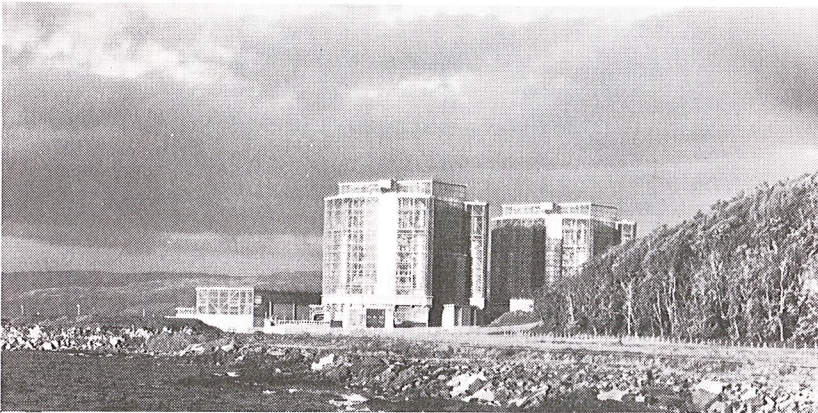
Heat generated by the chain reaction is usually carried away by a circulating gas or liquid—the coolant. It is taken to a heat exchanger, where steam is raised to drive a turbine and generate electricity. In one system, however, water is allowed to boil in the reactor core, and the steam is carried directly to the turbine.

The chain reaction is regulated by control rods made of substances such as cadmium, which readily absorb neutrons. By inserting the rods into the reactor, neutrons are removed from the reaction, which can thus be slowed or stopped.

Early Power Reactors

Industrial-scale reactors came into operation between 1954 and 1958, in the U.S.S.R., Britain, U.S.A. and France. This generation of reactors provided information and experience, but capital and electricity generating costs were substantially higher than those of equivalent coal- or oil-fired stations.

Electricity generating authorities in a number of countries quickly accepted the nuclear power station as being safe, reliable and flexible in operation. This reliability has been demonstrated by the U.S. naval programme. Naval reactors have propelled U.S. vessels over more than 8 million miles of sea route without a reactor failure.



Hunterston "A" Nuclear Power Station, Ayrshire, Scotland. The station has exceeded its designed output of 300 MW of electricity from its two reactors since commencing full operation in August, 1964.

Reactor Systems

Many different reactor systems are possible, using various combinations of fuel, moderator and coolant materials. Some use natural uranium fuel; others "enriched" fuel—i.e., fuel in which the proportion of fissile uranium (U^{235}) has been artificially increased.

Preliminary studies have been made of many reactor systems, but three main lines of development have provided nearly all the nuclear power stations of to-day:

Gas-Graphite Reactors, using natural uranium or slightly enriched fuel.

Light-Water Reactors, using enriched fuel, with ordinary water as coolant and moderator.

Heavy-Water Reactors, using natural or slightly enriched fuel, heavy-water moderator, and heavy water, light water or gas as coolant.

Years of Improvement

In each of these series, successive power stations were built, increasing steadily in output and efficiency. Each station in a series was an improvement on the last, and in each class of reactor there were many variations of engineering and design.

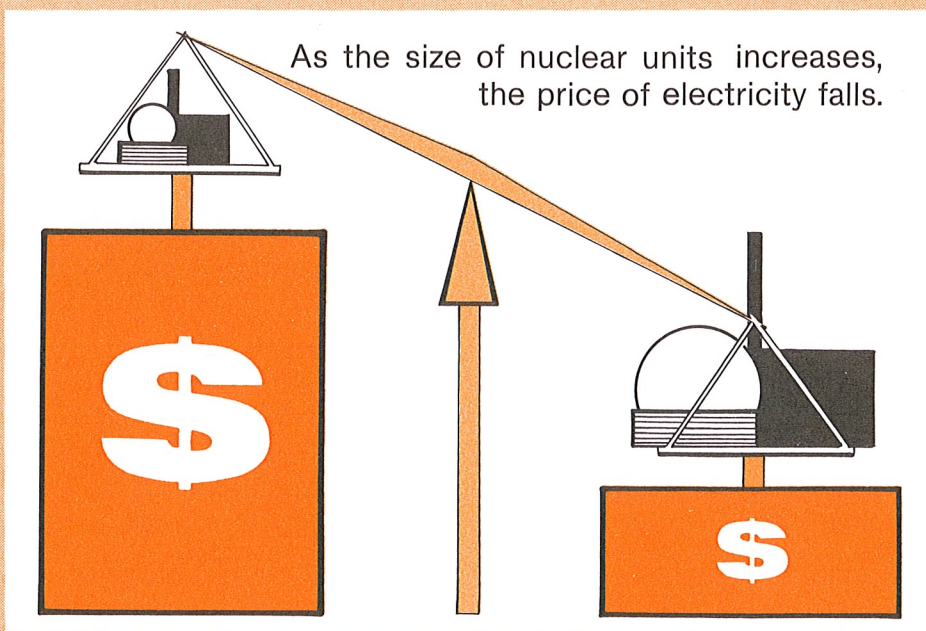
For example, in the earlier gas-cooled stations, the reactor was contained in a welded steel pressure vessel, with a concrete shield surrounding it as a protection against radiation. In later versions, the pressure-vessel and shield were combined by using a pressure-vessel of prestressed concrete. This makes possible a more compact design and higher operating pressures.

Improvements to fuel and materials have made possible more complete utilisation (“burn-up”) of the uranium fuel.

As more stations came to be built, many of the simpler components tended to become standardised. They became cheaper to produce by repetition methods.

Economies of scale were achieved. As the size of power reactors increased, from 50-100 megawatts(electrical) of earlier stations, to 500-800 MW(e), the unit cost of electricity generated fell substantially.

Meanwhile, as these reactor systems continue to be improved, considerable research and development work has been carried out on more advanced systems—notably the fast breeder. This will be capable of using about three-quarters of the potential energy in the uranium, as against only about one percent in present-day reactors.



Nuclear Power Competitive

As costs fell, it became cheaper in some areas to produce electricity from nuclear stations than from conventional stations—even though costs of generating electricity from coal had also been falling.

In U.S.A., for example, tenders for a large power station in Alabama, showed that the capital cost of a nuclear station would be slightly less than that of a coal-fired station.

Total capital cost	<i>Nuclear</i> \$247,000,000	<i>Coal-fired</i> \$258,000,000
Cost per kilowatt of capacity	\$116	\$117

Electricity will be produced so much more cheaply from the nuclear station, that the saving is expected to be \$8,000,000 a year.

In Britain, in 1965, tenders called for Dungeness "B" power station showed that electricity will be produced from this nuclear station at least 10 percent cheaper than it could be from the most modern coal-fired station being built in Britain near a source of coal.

Apart from direct cost advantages, nuclear power is preferred in some places because it discharges no gas or smoke to pollute the air.

FIRST AUSTRALIAN STATION

The Prime Minister, the Right Honourable John Gorton, announced on October 8, 1969, the Commonwealth Government's proposal to build a nuclear power station at Jervis Bay. He said the Government believed that Australia would make increasing use of atomic power in the years ahead and that the time had now arrived for this nation to enter the atomic age.

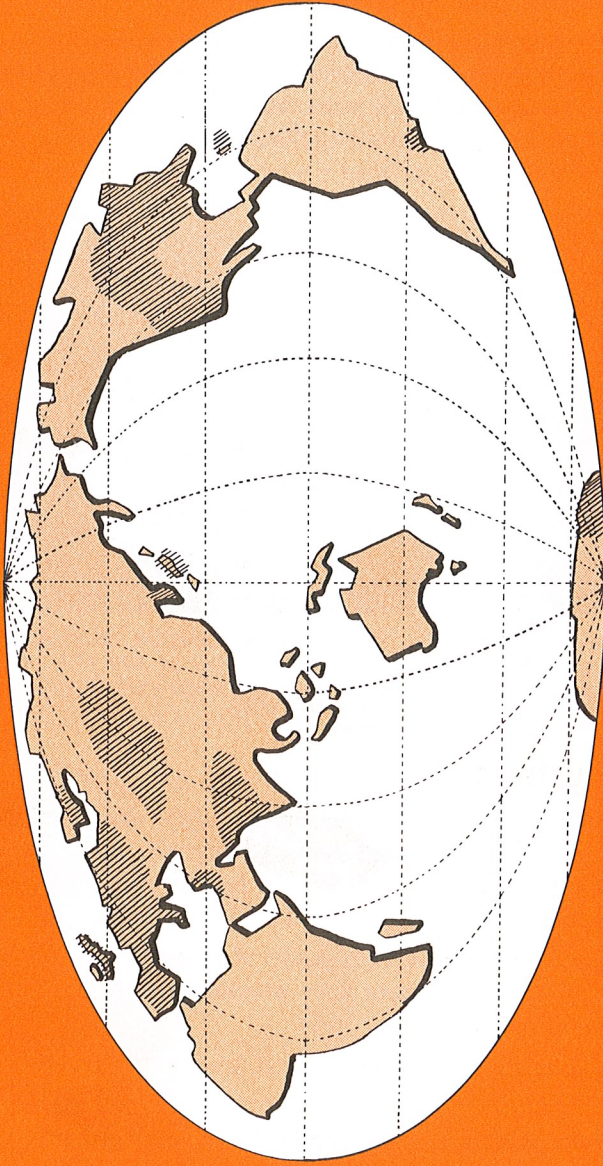
The site selected is at Murray's Beach, on the south-east tip of Jervis Bay. The station will be financed and owned by the Commonwealth, and will feed electricity into the New South Wales network.

The Australian Atomic Energy Commission, working in close consultation with the Electricity Commission of New South Wales and with help from other Commonwealth bodies, drew up specifications for a 500 megawatt station and called for tenders at the end of February, 1970.

The specifications were drawn up in broad terms so that suppliers of different power reactor systems could submit offers. The basic requirement was that the power station must be capable of operating on uranium fuel mined and fabricated in Australia.

Ten nuclear engineering companies are expected to tender. It is expected that a tender will be accepted before the end of 1970, and the station completed in 1975.

World Nuclear Power Development



Regions with nuclear power stations in operation and under construction.