

the space tug would only be able to operate in space, and it would be a general purpose ferry able to move from orbit to orbit, transfer material from the shuttle in near Earth orbit to a geostationary orbit, and possibly be equipped to land on the Moon. NASA is, of course, hard pressed for funds, but says that the European contribution is to be considered as an addition to the NASA budget rather than a substitute for part of it, although, of course, there is nothing wrong with sharing the cost of the space effort. Others have remarked that a helping of European participation will make the programme harder for Congress to cancel, but people with longer memories will say that foreign interest did not help Skybolt.

NASA continues its efforts to sell the shuttle and space station projects to the scientists, but it is problematical whether last month's conference at NASA's Ames Research Center had the desired effect. The kindest thing that some people can find to say is that the shuttle is a solution looking for a problem. Forty-five flights each year into near Earth orbits is taken as the starting point for the calculation of the economics of the programme, and on this basis the shuttle is expected to break even six or seven years after coming into service. Each shuttle will be used a hundred times. But it seems that this rate of almost one flight each week can only be justified if there is going to be a space station in the 1980s that will need regular servicing. NASA is at present working on the design of a twelve-man space station that would cost \$6,000-\$7,000 million for an operating life of ten years. Many people remain unconvinced that the scientific payoff from manned space stations and shuttles would be worth the effort, however, and in any case the cost of launching satellites is frequently not the chief expense.

ENERGY

Science and Power help Each Other

by our Washington Correspondent

THE Office of Science and Technology has cast itself as peacemaker and problem solver between the electric power companies and the environmentalists. This week Dr Edward David, the newly appointed President's science adviser and director of the Office of Science and Technology, released the report of a study group that aims to balance the conflicting needs of building more power plants and protecting the environment. The report's chief recommendations are that proposed sites for power plants should be announced by the utility companies at least five years in advance so as to allow public debate and approval by the relevant agencies. The pace of research in the electric power industry should be stepped up considerably in the fields of treatment of material and heat wastes, underground transmission and new forms of generation.

In his first press conference since succeeding Dr Lee Dubridge, Dr David chose to use the report as a platform for extolling the practical benefits of scientific research. "After two decades of technological advances in defence and space—many of which have not affected the everyday life of the general public directly—we are now calling upon scientists and engineers to improve the electric power system that serves our daily needs. . . . It is not too much to hope that the ingenuity and

scholarship that goes with a fine research and development programme can in the future remove these issues from the need for public debate." Dr David added that "scientists all over the country have made clear their desire to work on these problems".

The President's science adviser could not have chosen a more topical issue with which to dramatize the contribution science can make to soothing the nation's domestic ills. It only took an unusually hot day last month to cause power reductions or "brown-outs" across much of the east coast. In the electric power interconnexion serving Pennsylvania, New Jersey and Maryland, seven generating units were out of action before the heat wave started and another three gave out in the course of the day, resulting in a 30 per cent reduction of the system's full operating capacity. Although unreliable equipment and shortage of suitable fuels are the chief bottlenecks in power supply at present, a shortage of generating capacity is looming large for the future. Demand for electric power is expected to triple or quadruple over the next twenty years, but environmentalists' protests are growing in measure.

In view of this impending crisis the OST study group finds it anomalous that the electric power industry collected operating revenues of \$16,500 million in 1968 but invested only 0.23 per cent of this revenue in research and development. The OST report recommends a vigorous programme to iron out some of the snags in present methods of power generation and to develop new methods. A minimum of \$250 million should be spent over the next seven years or so on methods of treating the various pollutants emitted by power plants, including sulphur dioxide, nitrogen oxides, tritium and other radioactive substances, and waste heat. Over the same period at least another \$50 million should be devoted to research on underground transmission technology, the chief benefit of which would be to relieve the present narrow options of where to site power plants. The practicality of forced circulation or direct cooling of high power cables should be investigated along with the age old pipe dream of superconducting cable systems.

Turning to new forms of generation, the OST group would like its bets to be placed as follows. The liquid metal cooled fast breeder reactor, which received \$125 million of research funds last year (\$100 million of it from federal sources), should be pushed to the tune of \$150 million annually over the next 15 to 20 years. It is worth investing a total sum of \$500 million over 15 years on research into magnetohydrodynamics, of which the most promising application for power generation at present uses hot gas from combustion of fossil fuel. Combined gas turbine-steam turbine cycles merit a total research investment of \$100 million over the next 5 to 10 years; fuel cells, because of their high efficiencies in small units, merit a similar sum over a rather longer period; and the hopes of controlled thermonuclear fusion should be given substance with expenditures rising to \$200 million annually over the next 20 years. Finally, \$100,000 a year should be invested in studying means of harnessing solar energy.

The OST report recommends that the National Academy of Sciences and the National Academy of Engineering should set up panels to study the long term effects of power plant emissions, both conventional and radioactive, on the atmosphere and ecosystems.