tion, the report suggests, are drilling techniques, methods for assessing the size and deliverability of geothermal resources, binary fluid systems for extracting energy from reservoirs which are too cool to provide steam to drive turbines directly, desalination of brines to extract minerals and to provide fresh water along with energy and on the environmental effects of exploiting geothermal power. So far, federal funding on such problems has been small, and there has been a lack of a defined programme for exploiting geothermal energy.

If the report on the potential for geothermal energy is optimistic, the report dealing with solar energy is no less rosy. Prepared by a panel organized jointly by the National Science Foundation and the National Aeronautics and Space Administration, the report concludes not only that "there are no technical barriers to wide application of solar energy to meet US needs", but also that a "substantial development program" could meet the necessary technical objectives by the year 2020. By that date, the panel believes that solar energy could provide economically up to 35 per cent of total building cooling and heating, 30 per cent of gaseous fuel used in the US, 10 per cent of the liquid fuel and 20 per cent of the electric energy requirements.

All that is needed for solar energy to live up to these predictions is a research and development budget of some \$3,520 million over the next 15 years, some technological breakthroughs and the work of market forces which are expected to increase the cost of energy from other sources to make solar power more competitive. In short, the panel suggests that "on close examination, the possibilities for the economic use of solar power, given reasonable R and D support, appear much better than generally realized".

The research and development programme outlined by the panel would concentrate on three chief areas of direct use of solar power—thermal energy for buildings, the production of fuel from organic materials and electric power generation by thermal conversion and by photovoltaic cells—and in addition the panel suggests that wind energy and thermal differences in the oceans could be tapped for electric power generation. Major technical problems remain to be solved in each area, but if the funding is made available, the panel believes that solar power could be used to heat buildings in about 5 years' time and cool them in about 6–10 years, that synthetic fuels could be produced from organic materials in 5–8 years and electricity in 10–15 years.

Residential heating and cooling "has the highest possibility of success", the

panel suggests, but there is need for development of more efficient solar heat collectors for use on rooftops, and the efficiency of cooling systems powered by solar heat must be improved. Nevertheless, the costs of developing such a system are reckoned to be about \$100 million over 15 years, which is a small fraction of the predicted fuel savings.

One reason why both geothermal power and solar energy are receiving considerable attention in the United States is because they have the backing of environmentalist groups. The energy crisis seems likely to hurt the cause of environmentalists badly, particularly if they are blamed for part of the shortages by blocking nuclear power plants or the Alaska pipeline, and environmentalists are urging research and development on those forms of energy production which are likely to have the least impact on ecological systems.

Solar energy seems to fit that bill, since for applications such as building heating and cooling and electric power generation, little or no waste products are formed, and no resources would be depleted. Geothermal power production, on the other hand, is likely to involve noisy, dirty plants, and there is possible environmental damage from contamination of groundwaters with brines that are reinjected into the soil. Nevertheless, the environmental damage from such power plants would be

limited exclusively to the site, since they would use no transported fuel, nor require the disposal of radioactive or other toxic wastes.

Whether the hopes of the environmentalists or the rosy predictions of the two reports on solar and geothermal energy will be realized seem to depend chiefly on research funding and the solution of important engineering problems. The Administration is, however, understandably sinking its money into less technologically uncertain ventures, such as the breeder reactor.

BIOMEDICAL RESEARCH

Medical Ethics Examined

by our Washington Correspondent

THE Senate Health Subcommittee last week held three days of hearings on biomedical research involving human subjects, and it opened up a Pandora's Box of problems involving medical ethics. The hearings ranged over cases of unapproved contraceptive drugs being given to poor people in Tennessee and to university students in the United States, and they also took a look at some of the medical issues involved in the fields of brain research and psychosurgery.

Few questions were answered—that was not the object of the exercise—but with good stage management, human interest, pathos, displays of anger and, of course, the drawing power of

ASTRONOMY

Funds for Poland from the NSF

by our Washington Correspondent

THE National Science Foundation has announced that it will release \$1.4 million in Polish currency owned by the United States for construction of a centre for theoretical studies in astrophysics. The centre, which will be built in Warsaw, has been under consideration since 1971, and the announcement of the plans coincides neatly with the current celebrations of the 500th anniversary of the birth of Copernicus.

The money will be spent over three years, as part of the NSF's Special Foreign Currency programme, which uses currency derived chiefly from the sale of agricultural products for scientific purposes. The Polish Academy of Sciences will also put up about \$622,000 for furnishing and equipping the centre, and will support its operation. Poland is one of eight countries which benefits from the special currency programme.

The astrophysical centre will consist of laboratories, a lecture room, a computing centre, administrative offices and facilities for visiting scientists, housed in a building with some 56,000 square feet of floor-space. Construction is due to begin in June, and the building should be ready by October, 1975. It will be named the Copernicus Astronomical Center.

In November last year, the governments of the United States and Poland signed a broad agreement on cooperation in science and technology, which included plans for sharing of research data between scientists in the two countries and the exchange of personnel. Although the Copernicus Astronomical Center was being planned well before the agreement was reached, it is the first large project to be announced since the agreement was concluded last year.