USA

Assessing the 'greenhouse effect'

A report on the climatic effects of energy consumption was made public last week. Colin Norman reports from Washington

IF THE world's burgeoning demand for energy is met by burning increasing amounts of fossil fuels, there could be significant changes in the Earth's climate, lasting at least a millennium, a committee of the National Academy of Sciences warned in a report made public last week. Though the report is hedged with uncertainties and qualifications, the committee reckons that if the use of fossil fuels continues to increase at present rates, average global temperature could rise by about 6°C over the next 200 years, with potentially dire consequences for agriculture and fisheries.

The report, prepared by a committee headed by Roger Revelle, a noted ecologist who holds joint appointments at Harvard and the University of California, constitutes the first major attempt to assess the validity and potential consequences of the so-called "greenhouse effect", which may result from loading the atmosphere with carbon dioxide by burning coal, oil and gas. The theory is that carbon dioxide in the atmosphere will absorb heat radiated from the Earth's surface, causing an increase in global temperature, which in turn could trigger a variety of climatic changes.

The greenhouse effect was first postulated several years ago, but the theory has been controversial and the magnitude of its potential impact has been the subject of considerable debate. The Academy committee acknowledges that the data supporting the theory are incomplete, but the evidence is nevertheless strong and "the implications warrant prompt attention". Though the committee looked into other potential climatic impacts of energy use, such as the direct addition of heat to the environment and increasing the amount of particulates spewed into the atmosphere, it found that the carbon dioxide effect is likely to be far the most significant and it "may be the primary limiting factor on energy production from fossil fuels over the next few centuries".

On the basis of a number of climatic models and several years of direct measurements, the committee calculates that the concentration of carbon dioxide in the atmosphere has increased by between 11% and 13% from the beginning of the industrial

revolution to the present. It may increase by 25% by the turn of the century, double by the year 2050 and reach between four and eight times its pre-industrial level in 200 years' time, if use of fossil fuels continues to grow.

The effect of such a rise in carbon dioxide concentration would be a 6°C increase in average global temperature over the next 200 years and temperatures at the poles would be expected to increase even more, the committee states. In addition, precipitation is likely to increase and there could be severe regional changes in weather patterns.

It is important, however, to note the basis for those predictions first, the projected increase in carbon dioxide concentration is based on the assumption that use of fossil fuels will continue to grow as the industrialised countries switch from oil and gas to coal to meet their energy needs. Another key assumption is that per capita energy consumption will increase and that population will rise to a level of 10 billion toward the end of the twenty-first century. Those projections could be greatly affected by policies to curb the environmental impact of strip mining, by deliberate attempts to convert to other energy sources, by efforts to curb energy demand, and by policies to restrict population growth. The report's con-

clusions are therefore essentially based on an extension of present trends.

The projections are, however, founded on some key measurements of carbon dioxide concentrations at sites in Hawaii and the South Pole over an 18-year period during the 1960s and early 1970s. The measurements, made by Charles D. Keeling of the University of California at San Diego, are the first positive confirmation that carbon dioxide levels are increasing. They indicate that carbon dioxide concentration increased by about 5% over the period, and they suggest that about 40% of the carbon dioxide released into the atmosphere had remained there. The committee concludes that about 40% of the carbon dioxide released during that period was taken up by the terrestrial biosphere and the remaining 20% was taken up by the oceans. The projections of a doubling of carbon dioxide concentration over the next century and a four-to-eight fold increase by the year 2050 are essentially an extension of those calculations and measurements.

The link between increasing carbon dioxide concentrations and increasing global temperature is based on a computer model of the Earth's climate which the committee acknowledges is "imperfect in a number of significant ways" but is "the most complete yet devised". The model predicts a 3°C increase in the temperature of the lower atmosphere for each doubling in carbon dioxide concentration, and a

TVA appointment

PRESIDENT CARTER last week gave a clear signal of his intention to set a new course for the giant Tennessee Valley Authority (TVA) by nominating S. David Freeman, an advocate of energy conservation and solar power, to fill a long-standing vacancy on TVA's board of directors. Freeman, who first came to prominence when he directed the Ford Foundation's multi-million dollar Energy Policy Project, is also expected to become chairman of the three-member board when the present incumbent, Aubrey Wagner, retires next year.

Established in the Great Depression as part of Franklin Roosevelt's New Deal, TVA has developed into the largest electric utility in the United States, serving an area the size of Great Britain. It was created primarily to raise the economic level of one of the poorest regions in the United States, but energy supplies

dominated operations. It is the largest single purchaser of strip-mined coal, and has had a bitter battle with the Environmental Protection Agency over its policy of dispersing pollutants from its power plants through tall smokestacks. TVA has also embarked on a massive nuclear programme, with plans to have as many as 17 nuclear reactors in operation by the mid-1980s.

Critics have contended that TVA's poor environmental record, and its relative neglect of alternative sources of energy, are a far cry from its original goal. Carter has echoed such complaints. Now he has indicated that he would like the authority to recapture some of the innovative spirit which predominated during its early years. Freeman is at present an assistant to James Schlesinger, Carter's chief energy adviser.

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7% rise in average precipitation.

The effects of such an increase in temperature could be serious. The committee notes that there would be a poleward shift in the world's agricultural zones, marked changes in the location and extent of arid and semi-arid zones, and potentially serious changes in regions of precipitation. For the north American breadbasket, for example, the effect could be to push the corn belt northwards off the productive soils of the midwest and on to poorer Canadian soils. The impact on the oceans could be even more severe. A warming of the surface layers could be expected, which would reduce vertical circulation, thereby reducing the biological productivity of the oceans because it would depress the circulation of nutrients. There would also be a significant shift in the location of the major fisheries.

A five-degree warming of the upper 1,000 m of ocean water would also raise the ocean level by simple expansion by about 1 m. Melting of sea ice would augment the rise in ocean level. As for the potential impact on the polar ice caps, the committee states that "in the present state of understanding, it is impossible to forecast what might happen to the Greenland and Antarctic ice caps". Since temperatures over the ice caps would be expected to remain below the freezing point, however, "melting at or near the surface of the ice probably would not occur". But increased precipitation associated with increased levels of carbon dioxide could lead to substantial increase in ice thickness, which in turn could cause severe stresses at the base of the ice caps and surges and slides of ice into the sea. "If these surges resulted in destruction of the west Antarctic ice cap, there might be a corresponding rise in sea level of about 5 m within 300 years", the committee notes.

The report does not consider in detail the potential impact of global warming on regional weather patterns, climatic variability and shifts in ocean currents because of the difficulty predicting such effects.

The committee's chief recommendation is that a major research effort should be instituted, on a worldwide basis, to address some of the major unknowns in the climatic models and measurements on which the projections are based. Such an effort could cost between \$20 and \$100 million a year, Revelle suggested last week.

The report's chief impact, however, is likely to be on discussions of energy policy. The committee notes that if the potential for climatic change is substantiated, it may be necessary to reverse the trend of consumption of fossil fuels. The committee adds: "In

Jupiter success

THANKS to an intense lobbying effort by space scientists, university administrators and Governor Jerry Brown of California, the Jupiter Orbiter Probe, a key space science project, has survived a strong challenge in Congress. The House of Representatives last week rejected a recommendation from its powerful appropriations committee that the project should be killed, and voted funds to begin building the spacecraft next year. Since the Senate had already approved the project, the House vote constitutes the final go-ahead.

The Congressional debate over the Jupiter project provides an object lesson in the politics of big science. It also demonstrates the power that the scientific community can muster when it unites behind a major project.

Long considered a top priority space science mission, the Jupiter Orbiter Probe will involve the launch in January 1982 of twin spacecraft to orbit Jupiter and send scientific instruments into the planet's atmosphere. The total cost is expected to be close to \$300 million. Though the project has been on the drawing board for several years, this is the first year that the National Aeronautics and Space Administration (NASA) has asked Congress for funds to begin building hardware.

NASA officials were not anticipating much opposition to the project from Congress, and they consequently received a shock earlier this year when a House appropriations subcommittee, chaired by Edward Boland of Massachusetts, recommended that all funds for the mission be deleted from NASA's budget. The subcommittee's action, which was later upheld by the full appropriations committee and the House itself, was based on the fact that NASA was also requesting funds to begin building the Large Space Telescope. The subcommittee said that it would be willing to sanction only one major space science project, and it opted for the telescope.

Once the subcommittee's vote against the project was made known, the scientific community mobilised to reverse the decision. A flood of letters and telephone calls descended on

members of the Senate appropriations committee in an attempt to persuade the Senate to keep funds for the Jupiter project in its version of the NASA budget bill. The lobbying was successful, and it was then widely expected that when differences between the House and Senate versions of the budget bill were ironed out by a House-Senate conference committee, the Jupiter project would emerge with sufficient money to meet the launch schedule. But further problems arose.

House members of the conference committee refused to compromise on the project, insisting that it must be dropped in order to provide more money for higher priority efforts. Senate conferees, similarly, insisted that the project be allowed to proceed. To break the deadlock, the matter was referred back to the House for a separate vote last week. The lobbying was at its most intense shortly before the House vote.

The Jupiter Orbiter Probe is the only planetary project up for approval, and NASA officials thus argued that if it were killed there would be a major hiatus in planetary research. Abandoning the project would result in breaking up teams of scientists and engineers who have been working on planetary programmes, and continuity from one project to another would be lost, NASA officials argued. Moreover, since there would not be another suitable launch window until 1987, denial of funds for the project this year would effectively put Jupiter out of reach for another five years.

The chief political asset for the project, however, was the fact that it will be based at the Jet Propulsion Laboratory in California, a state with a large Congressional delegation and considerable political muscle. Alarmed at the prospect of losing a \$300 million federal project, Governor Brown telephoned a number of Congressmen before last week's vote and urged them to support the project. As a result, the California delegation united with other supporters of the project, and the opposition of the appropriations subcommittee was easily overcome. The vote in the end was 131 to 280.

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the face of so much uncertainty regarding climatic change, it may be argued that the wisest attitude would be *laissez faire*. Unfortunately, it will take a millennium for the effects of a century

of fossil fuels to dissipate. If the decision is postponed until the impact of man-made climate changes has been felt, then, for all practical purposes, the die will already have been cast". □