the German-Brazilian nuclear agreement were approved by the International Atomic Energy Agency, with both the United States and the Soviet Union voting in favour.

Although none of the reactors or fuel processing equipment specified in the nuclear agreement actually has been built yet, the accord most definitely is being carried out, as the head of Nuclebras, Nogueira Batista, said.

More than 100 Brazilian scientists are taking specialised training in Germany, and the Brazilian government has allocated generous amounts of

funds to local universities to expand programmes in nuclear-related fields of science. German atomic technicians already are working in Brazil. Adverts in newspapers are seeking secretaries fluent in Portuguese and German. Six subsidiary firms have been set up under Nuclebras to implement the agreement. These companies are to operate in areas such as nuclear technology and engineering, heavy equipment manufacturing, uranium prospecting and mining, and isotope enrichment.

Financing arrangements already have been completed for the first two 1.3

million-kilowatt German reactors that will be built in Brazil, with knowhow and components to be supplied by Germany's Kraftwerke Union. Related contracts have been signed between other German and Brazilian companies and consortiums, private as well as governmental, for site clearing and preliminary building construction.

Unofficial calculations show that over \$1,000 million-worth of cruzeiros, marks and dollars have been spent or committed under the German-Brazilian nuclear agreement so far. □

USA

Talk about the weather

Unusual weather encourages discussion of weather modification. Colin Norman reports on the debate in the western United States

THE strange weather patterns which have brought freezing temperatures and record snowfalls to the eastern United States this winter have brought the opposite problem to many western states. A severe drought is threatening agricultural production in California and it may disrupt hydroelectric power supplies in the Pacific northwest. And in the Rocky Mountain states the snow cover is so thin that the spring runoff is unlikely to be sufficient for crop irrigation, ranching, industry and domestic needs. In short, while the east is bracing for possible floods when the thaw comes, the west is facing a debilitating drought.

One consequence of this topsy-turvy pattern is that considerable public interest has been rekindled in the use of weather modification techniques to try to increase snowfall on the western mountains before spring arrives. The most dramatic expression of such interest came in Colorado earlier this month, when the state legislature approved a bill to provide up to \$250,000 for cloud seeding operations in the state. A major effort is also under way in Utah, some seedings have taken place in California, Oregon and Washington state, and an extensive long-term weather modification programme is also under discussion for the upper Colorado basin. One product so far is the generation of a good deal of local controversy.

This year's anomalous weather patterns have been caused by a stationary ridge of high pressure off the west coast, which has disrupted the normal westerly winds. Usually, the prevailing westerlies bring winter storms in from

the Pacific to dump snow on the mountains in the western states, but this year the winds have been deflected northward and have looped through Canada to descend on the eastern United States. The consequences in the east have been dramatic; in the west they have been more subtle.

Very little rain or snow has fallen in the Pacific northwest since September, and some industries which depend on hydroelectricity may face power reductions of 25% by the end of this month. Fire hazards abound in forest areas which are usually under several feet of snow at this time of the year. In California, domestic water supplies are already being rationed in Marin County near San Francisco, and last week the Bureau of Reclamation (an agency in the Department of Interior) notified farmers in the San Joaquin Valley that their irrigation water may be cut by 75% later this year. California produces about 40% of the fresh fruits and vegetables consumed in the United States. In Utah and Colorado, snowfall has been about 30-40% of normal, and as a result ranchers are selling off cattle because they cannot get sufficient feed and the winter wheat crop may be in jeopardy.

Another, more distant problem is likely to arise because spring runoff from the Colorado Rockies supplies most of the water in the Colorado River, which in turn provides much of the irrigation and drinking water for parts of Arizona, California, Nevada and northwestern Mexico. Though water now in storage in Lake Powell behind the Glen Canyon Dam and in Lake Mead behind the Hoover Dam will be sufficient to meet downstream needs for at least a couple of years, if this year's weather patterns are repeated next winter, some serious problems could occur. Small wonder, therefore, that weather modification techniques are attracting attention.

They will not provide salvation, however.

The legislation in Colorado will provide funds for massive cloud seeding operations during the rest of this winter on the western slopes of the Rocky Mountains, using silver iodide generators on the ground. Some airborne seeding will also take place in the eastern plains. In Utah, routine cloud seeding, sponsored by the Utah Water Conservation Board, has been undertaken for the past three years, and this year it is being expanded to cover nearly two-thirds of the state.

It should be noted, however, that cloud seeding can only increase natural precipitation; it cannot create snow when the conditions are not right for snowfall. Thus, the Colorado and Utah cloud seeding efforts will only be conducted if westerly winds return to bring snow clouds to the Rockies. According to a spokesman for the Colorado Water Conservation Board, the seeding programme will, at best, increase spring runoff this year by about 200,000 acre feet, an amount which will certainly not wipe out the anticipated shortages.

In a normal year, spring runoff from the Colorado Rockies into the Colorado River amounts to about 11 or 12 million acre feet. This year, Colorado officials are estimating that the runoff will be down to about 7 million acre feet.

Although any contribution from cloud seeding would be a help, environmentalists in Colorado vigorously opposed the emergency legislation when it was under consideration in the state legislature. Kevin Markey, a representative of Friends of the Earth, said last week, for example, that "it isn't emergency cloud seeding legislation, it's emergency political legislation to let everyone know that the governor and legislature are doing something". Markey argues that the time and effort spent on cloud seeding would be better devoted to water conservation programmes.

Environmentalists are particularly concerned about plans for a possible

massive cloud seeding effort now under discussion in Colorado and Utah, which would entail regular seeding of winter storm clouds to try to increase spring runoff to the Colorado River each year and boost water supplies to the arid southwest. A pilot-scale seeding effort was conducted by the Bureau of Reclamation in southwestern Colorado between 1970 and 1975 to measure the impact of cloud seeding on snowfall, and to evaluate potential long-term environmental consequences of a major effort covering most of the state. The results of that pilot effort were released last month, and they are adding to the debate.

The pilot project came up with two seemingly contradictory conclusions. First, it indicated that regular seeding may increase the snowpack by about 10%. And second, it seemed to show

that there was no statistical difference in the amount of snowfall on days when seeding took place compared with days of natural snowfall. Officials in the Bureau of Reclamation explain the contradiction by arguing that the seeding sometimes increased snowfall outside the target area, and residual silver iodide in the air often increased snowfall on days after seeding took place. Some seeding also took place on days when the conditions were not right for snowfall, which masked the overall effect, they claim. The ambiguous results are adding fuel to the debate about the advisability of sinking large sums into seeding this year, however.

The pilot project ended in May 1975, and discussions are now under way between officials in Utah and Colorado and representatives of the Bureau of Reclamation over the possibility of

expanding the effort into a large-scale demonstration programme. The Bureau has no money in its budget to begin such a project, however, and the earliest it could be started would be the winter of 1978-79. In the meantime environmentalists, who fear possible long-term effects on wildlife, increased damage from avalanches and potential effects on rainfall downwind from the target area, will continue to urge that water conservation be supported instead.

Whatever the outcome of that debate, it will not help alleviate the anticipated drought this spring. That would require at least twice the average snowfall between now and April, a prospect which weather forecasters deem extremely unlikely. As Colorado's Governor, Richard Lam, stated when he signed the emergency cloud seeding legislation, "It's a roll of the dice". □

BRITAIN

Solar commitment

Britain moved another step in its efforts to implement a broad national energy policy with the announcement last week of a programme supporting the exploitation of solar power. Chris Sherwell reports

A POSITIVE but measured commitment to solar energy from the UK government; a positive but measured response from the country's solar energy lobby. That was the state of play at the end of last week after the Department of Energy (DEN) had unveiled its latest research and development programme, this time in the field of solar energy.

The announcement, neatly preceded a day earlier by a DEN junior minister's well-publicised visit to a solar heated house to reaffirm the commitment to explore alternative energies, was timed to coincide with the long-delayed publication of a report prepared for the DEN by its Energy Technology Support Unit (ETSU) based at Harwell*. In following earlier announcements in support of wave and geothermal power it marks another step towards comprehensive exploitation of renewable sources of energy. Reports on combined heat and power and on tidal energy are expected in the next couple of months.

The new commitment of resources to solar energy amounts to £3.6 million over four years, and is expected to bring total government expenditure in the area to about £6 million over the same period. The £3.6 million will be

concentrated on three principal activities: the use of solar energy for water and space heating (the ETSU report sees this as offering the best return), the collection of additional data on solar energy, and the biological conversion of solar energy.

DEN officials were reluctant to indicate precisely how it would be allocated. An important fraction will go to work on biological conversion, but the bulk of the money will be used to accelerate the development of suitable solar power appliances. The DEN's idea is to negotiate contracts with companies with satisfactory proposals, offering them up to 50% funding to reduce the risk involved and encourage the work.

Much of the support will also complement work done by the Department of the Environment, notably through the Building Research Establishment. DEN funds will not be used to finance R&D on photovoltaic devices, however. This is already being done under the aegis of the Department of Industry.

The International Solar Energy Society in Britain (UK-ISES), though welcoming the latest development as a "good starting point" and though in agreement with the balance struck by the DEN, points out that the UK commitment compares unfavourably both in amount and in time-scale with that in other countries.

The UK-ISES also points out that in its report released last year, *Solar Energy: a UK assessment*, it estimated that solar energy could make an energy contribution of 35 million tonnes coal equivalent (mtce) by the year 2020—about 10% of total energy needs. It

urged an immediate incremental budget devoted to solar energy, beginning at £2 million a year in 1976 and reaching £10 million by 1980.

Dr Walter Marshall, the DEN's Chief Scientific Adviser, citing the ETSU report, said solar energy could be making a contribution of "around 2% of our present requirements" within 25 years (some 7 mtce), an amount which could represent a "take-off point" and might be increased by a factor of about 10 over the ensuing 25 years or so. But it was hard to assess the real potential, he said, since the trends in fuel prices weren't known.

Dr Marshall paid tribute to the UK-ISES for the quality of its report. And in response to a question about the delay in the government's announcement of a programme and in publication of the ETSU report—research for it was completed 20 months ago, in July 1975—he acknowledged that he had made a mistake in not setting the wheels turning in the DEN in anticipation of a favourable verdict.

That seemed like a surprising admission. But in a country blessed with a surfeit of energy for the medium term from its oil, gas and coal resources and its existing nuclear programme, the error of judgment seems more understandable. Still, the UK-ISES emphasises the opportunities even to an energy exporter offered by solar energy investment—especially in the field of export.

The UK ISES's enthusiasm for solar energy is not based just on faith. In January alone it received five telephone calls a day and 253 written enquiries from non-members. The newly-won enthusiasm of the DEN cannot be so complete. There the real fight is between coal and nuclear power. □

*Solar energy: its potential contribution within the United Kingdom (London, HMSO, £3.00).