of the results at a meeting of the Institution of Chemical Engineers on October 31.

The survey, which covers the period from 1960 to 1966, showed the impressive dominance of American companies in the building of chemical plants. Two thirds of the exported plants by value and one half by numbers had been built by American companies, and the average size of the American contracts was much greater than those undertaken by European and Japanese companies. Unlike the computer market, this dominance was not based on one or two companies of enormous size, but on twelve to fifteen medium sized firms. It is even odder, perhaps, that these firms usually do little research and development—only one or two are research intensive, according to Mr Freeman. Their access to technology seems to be through their client companies. In Europe, the German, Italian and British have 10, 9 and 8 per cent of the world market respectively, while the French firms are very weak.

Mr Freeman went on to discuss the policy implications of the survey. It had been argued, he said, that contractors could manage without domestic innovation, if they were quick enough to imitate foreign technical developments. The survey did not support this point of view; there was good evidence that foreign sales were proportional to the amount of domestic innovation. Furthermore, the study suggests that to be good at imitation the industry must also be good at innovation—the best innovators are also the best imitators. This is shown by the Pilkington float glass process, which was adopted under licence first in the United States, then in Japan, and finally in Europe.

How can Europe improve its performance in this important market? Mr Freeman suggested two ways of improving the flow of technology from client to contractor. One is by vertical integration, in which large chemical or oil companies buy contracting firms and form a larger group—the best example of this approach is ENI and Snam Progetti in Italy. The other approach, followed by American companies, is to collaborate on the exchange of information at a very early stage in the development of new processes. Most people at the meeting seemed to think that this is the best approach, if it can be achieved.

SCIENCE POLICY

Deciding What To Do

THE long-awaited report on Canadian science policy, just published by the Science Council in Ottawa, contains few surprises. It says that applied science in Canada should be organized into a number of major programmes, each of them—in the current jargon—mission-oriented and multidisciplinary and each controlled by a body specially created for the purpose. The first two proposals, which are intended to test the system of organization and coordination, should cover space research and water resources research. According to the report, four other major programmes should be planned immediately—in transportation, urban development, computer applications and scientific and technological aid to developing countries. Once these are launched, attention should turn to planning six more programmes—health care delivery systems (which means health services), the development of the North, the development of energy sources, integrated resource management, oceanography and weather prediction and control.

The council does not conceal the difficulty of relating expenditure on research and development to growth of national prosperity. Because no proper theory yet exists to relate the two, the council has fallen back on its "own informed judgment" in making the recommendations. Moreover, the council does not attempt to estimate how much the programmes are likely to cost. On the one hand, it says that attempts to assess costs would be premature; on the other, it says that it is impossible to set a target figure for scientific expenditure within which the programmes have to be fitted. The council thus exposes itself to charges of political naivety—it is certainly bold, if not foolish, to attempt to determine priorities without counting the costs. It does say, however, that the widely discussed target of 2 per cent of the GNP to be spent on research and development is over-cautious and will be surpassed.

The other weakness of this plan for Canadian research is the council's insistence that each programme should be run by a specially created agency. The space programme, for instance, should be run by a Canadian NASA while the water resources research should be coordinated by a National Advisory Committee on Water Resources. Such organizations, as the report admits, tend to become self-perpetuating and, if no department of government is directly responsible for them, the task of closing them down becomes difficult. Equally, if these organizations have no voice in Treasury discussions, they run the risk of being starved of resources.

But the council has some sensible things to say about industrial involvement in the research programmes. Its general recommendation, now a familiar theme in Canada, is that industry should be given a much larger part in national research programmes. Federal research programmes should be contracted out to industry, and government procurement should be used as a way of "upgrading the technological level of Canadian industry". The council even raises the possibility that research programmes carried out by industry should be entirely financed by the Government.

The council has also drawn up a list of criteria which must be met in selecting new programmes. The objective must be of real importance to Canada, perhaps even unique to Canada; no major programme should duplicate work in progress elsewhere; there must be some demonstrable economic or social benefit; the technology must be challenging, yet realizable within a reasonable time; the programmes must be large enough to produce research groups of above the critical size; and the programmes must be based on a conjunction of need and scientific opportunity.

NATIONAL PARKS

Ford to the Rescue

THIS week the Ford Foundation has announced that it is making $6 million available to the American Nature Conservancy to ensure that tracts of land earmarked by Congress as parks, wilderness or wildlife

reserves are saved from land speculators. Usually at least twelve to eighteen months elapse between the time when Congress authorizes a project and the time when the responsible Federal agencies—the Forest Service, the National Parks Service of the Bureau of Sport Fisheries and Wildlife—actually receive their cash appropriations and can buy the land. Apart from the normal increase in land values, currently rising by about 7 per cent per year on the average, this leaves plenty of time for land speculators to buy key tracts and grossly inflate their price. One example, typical of many, is a 309 acre tract of land in the Ashley National Forest in Utah, an area now within the proposed Flaming Gorge National Recreation Area. In 1965 Congress authorized the Flamingo Gorge Dam and Reservation, and the Bureau of Reclamation valued the 309 acres at $39 an acre. The Bureau purchased 195 acres in 1959 for $43 an acre. By 1966, the Forest Service estimated that the remaining 99 acres at the site were worth $429 an acre, and the year before the State of Utah had to pay $929 per acre for 14 acres.

The Nature Conservancy has been trying to curtail this kind of escalation since it was incorporated in 1954. The conservancy is a private non-profit-making organization with total assets, including land and revolving capital, amounting to $15 million before the Ford Foundation's loan. Although it is a private organisation, the conservancy receives most of its funds from the entrance fees charged at federal recreation areas, federal motorboat fuel taxes and the sale of surplus Federal property. In practice, it acts as a stopgap purchaser of land for parks, buying only land included in projects authorized by Congress at the request of a government agency or at the request of state or local public agencies before speculators can step in. The conservancy then sells the land back to the Federal or state agencies when they have received their appropriations. The conservancy has no guarantee that the public authorities will always buy back the land, but if the public funds are not forthcoming it can always sell the land privately.

By offering $6 million credit, the Ford Foundation, using its capital for land preservation for the first time, has greatly strengthened the conservancy's hand in forestalling substantial losses of the American taxpayers' money. Indeed, it is no exaggeration to say that it may well have saved the whole Federal open-space programme. It is already plain that the federal funds currently available are not sufficient to cover projects that Congress has already authorized, with the result that Congress has lately been considering a moratorium on further purchases, which would, of course, bring the programme to a halt. With luck, as Mr G. Harrison at the Ford Foundation says, although "the funds and lands involved are relatively small, we believe the experiment will establish a significant pattern for considerably larger land acquisitions in the future by joint private–government efforts".

WATER RESOURCES

Bringing Industry in

CANADA has a great deal of water—perhaps as much as a third of the total surface water in the world. This is a resource too important to be squandered by reckless use or devalued by pollution; most Canadian industry, power generation and recreation relies on the continued supply and purity of fresh water. This is why the Science Council and the Science Secretariat, the two bodies responsible for defining scientific policy in Canada, have recently been turning their attention to the question of research on water resources. Both have recently published reports on the subject (*Science Council Report No. 3*, and *Science Secretariat Special Study No. 5*, 75 cents and $2·50, respectively), and both have drawn the same conclusions (which is hardly surprising, as the council used the secretariat's report as a source of inspiration). But there is one revealing difference; the council thinks that more of the research should be done by industry, while the secretariat sticks to the conventional view that government laboratories are the best place for it.

The secretariat report, written by J. P. Bruce and D. E. L. Maasland, concludes that "Canada has seriously underestimated water resource research" and that much more should be spent on it. At present it represents only 1·2 per cent of the total research and development budget; within ten to twelve years, the report says, this should be more than doubled, to 2·5 per cent. An annual increase in expenditure of around 20 per cent would have Canada spending $25 million a year by 1972–73, and $75 million by 1978–79. The council committee, chaired by Dr J. Tuzo Wilson, accepts that expenditures of this order will be called for, though it disagrees about where the money should be spent. It suggests that the need to increase industrial participation is pressing, and proposes that the proportion of the work done in industry should increase from 14·5 per cent now to 28 per cent by 1972–73; during the same period, the proportion carried out by government laboratories should fall from 66 per cent to 44 per cent. This view reflects the current Canadian drive to increase industrial research at the expense of almost anything else; the secretariat seems to be uninfected by it. It argues that in water management, government plays the usual part of industry, and that there are therefore no real grounds for recommending a change of emphasis.

The Science Council backs its case by pointing out that the production of equipment used in water programmes is now a large industry in its own right, worth $1,460 million in 1966. It also draws a parallel between water source research and geophysical surveying; much of the survey work has been done by industrial contract and the council suggests the same should be done in water research, while government laboratories should have only a small growth rate in their annual expenditures, enough to ensure that the administrators are kept up to date. A few major water research institutes should be established in the universities, and coordination should be the responsibility of the National Advisory Committee on Water Resources Research. The secretariat recommends certain areas for special attention—these are precipitation, streamflow, environmental aspects of pollution, groundwater, economic and social science aspects and network design and instrumentation. But the last of the Science Council recommendations returns to the familiar theme; in 1971, it says, there