from 50 to 100% higher than in the 1960s.

This may mean that by the 1990s energy costs will be twice or three times what they are today, and if per capita consumption is also 50 to 100% higher, energy costs could require from two to four times today's proportion of personal income. Canada's historical advantage in such energy-intensive industries as forest products, mining, agriculture, metallurgical and chemical industries could therefore be seriously attenuated. And if primary industries weaken, Canadians could not look to the secondary sector for compensation.

Dr Kates proposes that a much higher priority be given immediately to a comprehensive energy conservation programme, and that Canada must now begin to develop the energy technologies that will permit her to achieve a stable energy use pattern in the long run. This means exploiting renewable energy forms such as solar, wind, geothermal, biomass and tidal power. A major programme of research and development, of the kind first proposed by the Science Council in 1968, must be undertaken "to demonstrate the feasibility of alternative energy technologies."

A recent investigation indicates that "if we were able to hold Canadian energy consumption at present levels and continue to use existing or moderately-expanded hydro-electric capacity to provide approximately 25% of our energy needs, the remaining 75% (now met almost totally by nonrenewable hydrocarbons, oil, gas and coal) could be provided within the next 50 years or so by renewable resources such as solar, biomass and wind energy."

At the press conference Dr Kates described the Conserver Society study the council's largest and most important project. The concepts behind this study, outlined in the "Statement of Concern" published in *Science Forum*, are summed up in the comment that "we face a transition from a 'consumer society' to a 'conserver society' "—that is, to a society which included among its features "doing more with less," "a greater appreciation of external or social costs," a return to the habits of thrift, saving and avoidance of waste for society as a whole, and so on.

"The transition to a Conserver Society," the Science Council paper says, "does not mean that we are going into a period of austerity and shortages. In fact, it is the reverse. Only by adopting a more rational and conserving approach to the common energy, resource, and environmental pool that sustains us all, can we ensure a continuing high standard of living for future generations." □

THIRD WORLD

Talking about technology transfer

The transfer of technology from developed to underdeveloped countries, a subject examined at UNCTAD IV at the end of May, was also discussed at the recent World Employment Conference. Robin Sharp reports

SCIENCE and technology, said the man on the rostrum, could increase production everywhere "on a scale that would make poverty unnecessary as a global phenomenon within the foreseeable future." The speaker was a senior official of the United Nations Development Programme, addressing last month's World Employment Conference in Geneva.

But for many people his otherwise heartening words raised questions. How is the scientific know-how and technology of the rich to be adapted and made relevant to the needs of the poor? How are the benefits of these high-cost, skill-intensive fields to be transferred to those possessing limited skills and no hard currency? And how, at the end of the day, can it be ensured that the transfer does not enrich 10 men at the expense of a thousand others? Among the many dilemmas of development these are some of the most intractable, and the debates in Geneva proved it once again.

Some of the figures can be frightening. In the industrialised countries, the average investment required to create one job is in the region of $5,000. The developing countries, with most of the world's poverty, need to create five times as many jobs per million population in order to meet the basic needs of their people, with only one-tenth of the per capita income available to do it. Hence, on a rough rule-of-thumb calculation, an average investment of $250 per job is what they can afford. There is little science and less technology to be had for that kind of money.

On this fundamental issue, delegates to the World Employment Conference found themselves deeply divided. At one end of the spectrum, speakers denounced the appropriate technology movement as a neo-colonialist strategem designed to perpetuate the supremacy of the rich countries. In more measured terms, the French Minister of Labour also questioned the international division of labour proposed to the conference by the International Labour Organisation (ILO), whereby developing countries would specialise in the production of everyday consumer goods, using less sophisticated technology and unskilled labour, while the industrialised countries would concentrate their economies even more in the high-technology sectors.

Put more favourably, however, what the ILO was proposing in its report to the conference was a Basic Needs Strategy in which much greater effort in the field of appropriate technology was seen as essential for maximising the use of labour in the Third World. Given the present level of 300 million unemployed or underemployed in the developing countries, and their estimated need for 1,000 million new jobs over the next 25 years, the ILO strategy is to many the more persuasive formulation. With it has to be swallowed a slower rate of national growth, but in most developing countries the alternative—in terms of human and social cost—would be even less palatable.

Among Third World delegations, the Latin Americans in particular were convinced that they should "continue to incorporate the most advanced technology into those activities where it was necessary in order to eliminate the technological gap." At their preparatory meeting, by contrast, the African group had strongly endorsed the need for more work on appropriate technology as a matter of priority.

In the end, it was the western industrialised countries which blocked the ILO's proposal for two new bodies to promote efforts in this field. A Consultative Group on Appropriate Technology was suggested as a mechanism for mobilising resources and determining research priorities, linked with an International Appropriate Technology Unit designed to identify and focus research in areas where technological innovation would have a significant impact.

Again lacking the support of the employers and western governments, the developing countries and the workers' group declared their support for an international code of conduct on technology transfer, as proposed by UNCTAD a month previously in Nairobi. As well as recommending a timetable for drafting and adoption of this code by the end of next year, the UNCTAD meeting also agreed on the immediate setting-up of regional technological centres under the aegis of either UNCTAD or the UN Industrial

Development Organisation.

Attention was also drawn in Geneva to the damaging restrictive practices contained in a dusty old piece of international law—the Paris Convention of 1883—which defined industrial property rights for a world very different from that of today. With its regulations tivity techniques which would condemn the developing countries to a perma- on patents and like matters often working to the detriment of developing countries, they and the workers' group called for this Convention to be "drastically revised."

In its final report, the World Employment Conference endeavoured to strike a balance between the need for technologies which will generate the maximum possible growth of employment and the avoidance of low-producnently inferior role in the world economy. In practice, the technology choices of developing countries tend towards the capital-intensive end of the spectrum where work places will be few and far between for the one thousand million job-hunters in the year 2000. The danger is that what the report calls a "strategy of equilibrium" will be taken by most governments as an endorsement of whatever their policy now happens to be. □

USSR

Down Georgia way

Wendy Barnaby, recently in the Georgian SSR, describes some of the scientific work going on there

It takes two and a half hours to fly from Moscow to Tbilisi, the capital of the Georgian Soviet Socialist Republic. In this sunny space between the Black and Caspian Seas, the amount of human effort devoted to science depends on how successfully it—and everything else—competes with the five million Georgians' favourite occupation: the ceremonious consumption of their excellent local wines. And, as a few days spent with the Georgian Academy of Sciences shows, science is coming out of the competition extraordinarily well.

Astrophysical astronomy is concentrated in the southern republics of the Soviet Union, where the weather permits good observation. The air is especially clear on Mt Kanobili (1,700 m), 250 km from Tbilisi and only about 40 km from the Turkish border. Spread throughout the trees on the mountain top is the Academy's Abastumani Observatory, founded in 1937 as the first experimental mountain astro-physical observatory in the USSR. Work here is mainly concerned with galactic research. The resident scientists (including many women) study stars' spectra and classify them in order to examine the distribution of the stars according to their age and chemical composition. From such a distribution investigations are made of the structure of our galaxy. So far, about 100,000 stars have been classified, using a telescope whose diameter is the third largest in the world. During their last 20 years' research, the astronomers have discovered two of the 150 Supernova stars as well as about 100 emission stars.

The observatory's stellar telescope has a diameter of 125 cm and is the biggest fully automatic one in the USSR. The computer attached to it processes 1 million bits of information a second, and its memory stores 32,000 bits. Observations, which can be made on 160–170 nights a year, are mainly for determining the stars' chemical composition, physical properties and light variation. The solar telescope is used more frequently: generally on 260 days a year. Through studying the physical properties of solar flares and sun spots, the astronomers hope to be able to predict solar activity. They also do photometric and spectroscopic studies of optic radiation of the sun's atmosphere, and of radio emission at 220 MHz. The resulting data is shared under the Solar Service Programme.

Back at Tbilisi, the Underground Gravimetric Laboratory of the Academy's Institute of Geophysics is the centre of the Communist countries' cooperative efforts to study earth tides. Half burrowed into a hill overlooking the city, the laboratory is accumulating data which it is hoped will lead to the prediction of earthquakes. In tunnels leading off from basement passages, two double-component quartz extensometers composed of welded quartz tubes have been fixed so that their movements will reflect the tidal and secular deformations of the earth's crust, enabling these to be observed. Any movement is recorded photoelectrically, with a reading of 1 mm on the tape corresponding to a change of 0.1 micron on the ground. Between 1965 and 1972, the value of the recorded drift of one extensometer in the direction N 60° E was 11.9×10^{-6}. The value of deformation in the direction N 30° W between 1966 and 1972 was 14.7×10^{-6}.

Further down the passages, tiltmeters on basalt bases record changes in N–S and E–W directions. The instruments are housed in a chamber 60 m under the ground, where the diurnal temperature variation does not exceed 0.005 °C. From 1967 to 1972, the total drift in the N–S direction was 0.4 microns, and that in the E–W direction was 3.0 microns. The readings from both tiltmeters and extensometers are interpreted by the laboratory's staff as evidence of the existenc of secular movements of the earth's surface. So far there has been no success in using this knowledge to predict earthquakes: neither at this laboratory, nor at a new seismic station nearby, where equipment is being installed for the measurement of seismic waves from local and distant events. (Incidentally, the scientists at the station claimed that their research will enable them to locate and identify nuclear explosions in rock and in the Northern Hemisphere down to less than 10 kilotons. If the station were integrated into an international net, it could presumably contribute to the verification of any future comprehensive test ban treaty).

The Gravimetric Laboratory's methods are also being used to measure the earth's movements at a hydroelectric dam under construction about 50 km from Tbilisi. The plant, which will be completed in 1978, will have a capacity of 130 MW. Its artificial lake will hold 500 million cubic metres which will irrigate 45,000 hectares of land and supply drinking water to Tbilisi and its industrial area for 80–100 years.

Another of the laboratory's activities is the suppression of hail which threatens to destroy large parts of Georgia's grape crops every year. In 1974, 20,000 rockets containing silver iodide were launched from 34 automatically-synchronised firing points to save 360,000 hectares. Radar was used to detect clouds up to 15,000 metres, and results were good if the approaching front was narrow but not so good if it was broad. Because silver iodide is very toxic and expensive, research is being done into substitutes—ice with chemicals, for example.

In addition to coping with a heavy load of scientific work, a number of Academicians—including the Vice-President—represent Georgia in the Supreme Soviet of the USSR. This involves them in political activity to a degree extremely rare for active scientists in the West. Such involvement undoubtedly has its good and bad sides, but inasmuch as it contributes to the activism of science it seems a pity that Western scientists do not become more politically involved in their own societies. □